J. Nelson Spaeth.

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EDITORIAL

THE FORGOTTEN MAN IN FORESTRY

DURING recent years much has been said about "the forgotten man." To be sure, there has been no general agreement who really is "the forgotten man." Some would have him be the youth of America, others those past middle life, still others the farmer, or the urban wage earner; some would have him be the socially and economically unfortunate, others would have him be the taxpayer. With such a diversity of opinion, it almost naturally follows that "the forgotten man" simply does not exist in these United States.

It is probably equally difficult to determine who, if anyone, is "the forgotten man" in forestry. Some undoubtedly would have him be the unhonored and unsung cubicle inhabitant in Washington, others the ranger in a sparsely settled district of the far West; still others the forest researcher, or the forest administrator. However much these opinions may differ concerning who really is the forgotten man in forestry, it appears that no group of foresters can establish a more unquestionable claim to a questionable appellation than foresters in private employ in the United States.

In a word, the professional status, the sphere of action, and the economic position of most foresters in private employ in the United States is unsatisfactory. In many European countries quite the reverse situation exists despite the fact that in few, if any, European countries is so large a percentage of by far the best forest land owned by individuals and corporations as in the United States. What are the reasons for such an anomalous situation?

Public foresters, to be sure, may very easily place the blame either on the timber owner or on the private forester. On the other hand, the private forester may just as easily place the blame for all the ills and difficulties of private forestry on public agencies and programs, and the attitude of foresters in public employ. With equal ease the private timberland owner may blame whatever may be the shortcomings of private forestry on the education, training, outlook, and experience of all foresters—both in public and private employ.

Unfortunately for the progress of private forestry, there has been too much "buck passing," too much criticism by public foresters of the forest practice, or lack of it, by private timberland owners, too much criticism by private timberland owners of public forestry programs, too many generalizations of all kinds, too many excuses, too much loose talk, and too much downright "hot air." At the same time there has been too little vision, too little understanding, too little knowledge, and too little cooperation.

To speculate on who may be most to blame for the present position of private forestry practice in the United States is futile. Even if it were possible to place the blame rather accurately, the mere placing of it, gratifying though it may be to some groups, would help little in the solution of the problem. It would appear that there would be infinitely more potentialities in looking forward instead of backward, except perhaps for historical purposes. "Cooperation" is a much over-used and abused word. Nevertheless, never before has the need for a genuine cooperative approach to private forestry been so necessary as it is today.

One would be foolhardy indeed to attempt to write a solution for so difficult and complicated

a problem as adequate forest practice on all privately owned timberland. Despite considerable study of the problem from all points of view, no one either in public or in private employ yet seems to have been wise enough to show beyond any reasonable doubt that solution which is possible, feasible, and desirable from that which is impossible, unfeasible, and undesirable. That public foresters have a greater and more direct responsibility in this matter than do private foresters themselves requires no demonstration.

At the moment, however, two things seem quite certain. In the first place, the most rapid progress in private forestry will result if and when there will be found in the employ of all the larger owners and operators of private timberland an adequate staff of competent foresters with sufficient prestige and authority and possessing enough professional idealism to put into effect those forestry practices that will most probably result in the continued productivity of privately owned forest land and which at the same time are economically possible and socially desirable.

In the second place, if substantial progress is to be made, industrial or private forestry must be regarded to be what it actually is—a technical and professional, not a political question. In these matters American foresters might learn much from their Canadian colleagues. There the chasm between foresters in public and private employ seems to have been far more successfully and effectively spanned than in the United States. Canadian foresters appear to be much better able to discuss forestry problems, both public and private, detached from partisan politics and abstract economic philosophies. To be sure, the political and economic views one holds do affect one's approach and interpretation of all questions, but it seems reasonable to suppose that foresters should be primarily concerned with the application to all forest lands of the best forestry practices under existing economic conditions. Some day it is hoped that public and private foresters can get together around the conference table to discuss on the professional level and without passion or prejudice the many existing practical problems of private forestry instead of continually meeting on the rostrum to debate the question on unsound, unfounded, and unscholarly premises.

In the forty-odd years of American forestry, there have been many notable achievements: the creation of the national forests, the establishment of the forest experiment stations, the passage of the Clarke-McNary Act, and the passage of the Farm Forestry Act. These achievements are widely known and generally recognized. One of the greatest achievements of all, however, is not so generally known nor so generally recognized. This is the creation and development of a forestry consciousness in the minds of at least the more progressive private timberland owners. This forestry consciousness was created and developed under the most difficult and adverse circumstances. Many influences and many individuals contributed towards its creation. It would appear, however, to be a reasonable approximation to the truth to state that a considerable portion of the credit for its creation and development belongs to a comparatively small group of foresters who have interested themselves in private forestry. It is neither possible nor necessary to list all of the foresters who have made a significant contribution to private forestry practice in the United States. Among the leaders in this movement, however, are E. T. Allen, W. P. Good, J. W. Girard, C. S. Chapman, W. B. Greeley, John B. Woods, Emanuel Fritz, A. E. Wackerman, the late Austin Cary, the late Forrest H. Colby, the late W. W. Ashe, the late Ralph C. Bryant, and others. These men, often working more or less in obscurity, receiving little credit and often much blame, have made a distinct contribution to American forestry practice. Much still remains to be done. Present practices in many instances are far from adequate, and far too much privately owned forest land is still being cut with utter disregard to future productivity and social consequences. Nevertheless, a significant start has been made, largely due to the perseverance, the ingenuity, and integrity of a small group of foresters working for or with a comparatively small number of progressive, conscientious lumbermen. These foresters and these lumbermen have not received the professional recognition they so richly deserve. "The forgotten man" in forestry today is the key to the door of adequate forestry practice on the larger portion of the most productive forest land in the United States. He has already accomplished much, but it is sincerely hoped that these accomplishments are only the dawn of a new and much brighter era.

AS WE SEE IT

By VINCENT W. BOUSQUET and JOHN G. MILES
Northwest Forestry Company

During the past year, the JOURNAL OF FORESTRY has carried much discussion, both of the problem of unemployment among young foresters, and of the problems and future of private forestry enterprise in the United States. This article adds to the discussion the ideas and attitude of two men who have solved the first problem for themselves, and who have staked their futures on the eventual solution of the second.

JOURNAL readers are familiar with the conditions that created the unemployment problem in the profession. Beginning in 1933, and accompanied by publicity designed to sell it to the public, an expanded program of government conservation work attracted great numbers of men to the forestry schools. The resultant increase in enrollment was in excess of the potential demand for men even under sustained expansion. The curtailment of activity which has taken place within the last two years has virtually ended the demand for new men in government service, and has intensified to the point of extremity the problem of unemployment among recent and prospective graduates. With still larger classes yet to be graduated, it is apparent that the peak of the surplus has not yet been reached.

Little has or could be done by the Society of American Foresters or by any other interested group to relieve the situation directly. The problem is one that the graduates will, in the main, have to solve for themselves. Many of them were attracted to forestry in the first place by the promise of good jobs at regular pay. Following this logic, these men will doubtless move on without too much reluctance to other fields offering more immediate employment. The profession will suffer no great loss by their going. The profession will lose much, however, when the elimination process begins to squeeze out those men whose interest in forestry lies deeper than in the apparent plentitude of work once offered. It is reasonable to assume that these men will leave the profession reluctantly, and only after they have exhausted every possible source of employment in forestry. With government agencies closed to them, these men will, naturally, look next to private forestry.

Private forestry has not developed as it should, largely because the business of forestry has yet to be made attractive to most forest owners and investors. It has not been made to yield them dividends in the time and form they desire. Briefly, the factors which inhibit the development of private forestry are the generally unfavorable tax situation, the necessarily long rotations, the relatively low degree of utilization, and the unfavorable conditions created by competition between low-cost, high-value products from virgin or old forests, and high-cost, low-value products from second-growth and managed forests. Until these obstacles have been removed the practice of forestry on private lands will remain exceptional.

True, we have a few examples of paying forestry enterprises in this country. Outstanding are some of the community forests in the East, and some commercial operations in the South. But it is significant that in the first case, taxes present no unsurmountable problem; while in the second, the immediacy of utilization and the shortness of rotation are big factors in success. The public as a landowner can afford to take its dividends in forms such as recreation and watershed control; and the corporations practicing forestry on the West Coast can afford to wait several years for their dividends, being relatively long-lived. But most of those individuals who should be attracted to the practice of forestry want cash returns within a reasonably short time. If they are to practice forestry, they must be allowed to receive them.

It would appear that one of the greatest advances to be made in forestry is to effect the removal of these obstacles. We must somehow arrive at shorter rotations, closer utilization, less oppressive taxation systems that usually obtain, and a production base that will help prevent a recurrence of the present market stagnation. In addition, the modification of harassing tax and labor laws, and the stimulation of investment in all forms of business, will help forestry enterprises as it will business generally.

Other solutions to the problem of private forestry have been discussed in the JOURNAL. Some of them, apparently fathered by impatient minds,

aim at liquidating the problem by government acquisition of private lands, or by the socialization of forestry through government control. Is it presumptuous to suggest that with the removal of the obstacles mentioned, and with a reasonable amount of federal and state cooperation under existing cooperative laws, private forestry will prove to be its own solution?

The writers believe that the future of private forestry enterprise lies within itself, and that the spirit and intelligence that brought public forestry to maturity will effect the same development in private forestry. Our own planning for the future has been done in that faith. We expect to experience the same degree of success professionally that attends the solution of the problems of private forestry; and we hope to live, meantime, on the rewards we glean in the course of aiding in that solution.

Meantime, we have to build a place to stand on and fight from. We suggest to those other young foresters who refuse to be eliminated from their profession that they resist the squeeze by some means similar to those we have used. There are dozens of activities related to forestry by differing degrees that can be pursued profitably, and in which real public service can be rendered. In developing these new fields, it may be possible to make them lead one back to the actual practice of forestry.

A little over a year ago, five men with a common problem and a common faith in the future organized this company of consulting and practicing foresters and arboriculturists. Two of us remain, the others having found opportunity to follow prior interests in the Indian Service, forest pathology research, and plant genetics. We offered our services in pruning, fertilizing, moving, and repairing shade and ornamental trees; in disease and insect control; and in forest and woodlot management, timber surveys and appraisals, planting, and special research problems. Later we became dealers in tree seeds, and last winter sold Christmas trees and firewood.

Most of our activity has been in arboriculture. If that sounds like a far cry from forestry, consider that the same fundamental knowledge of the biological sciences is requisite to success in either field; and consider, too, the need that exists in arboriculture—in spite of efforts of some of its members to effect general reforms—for an infusion of sound technical knowledge and professional ethics. There is a great public service to be performed in tree work, and no forester need apologize for doing it.

Contrary to general opinion, much capital is not necessary to launch a business that has for its stock in trade the intelligence and training of its members. The danger lies not in having too little capital, but in having too much; and it is important that the very things which tend to keep men out of a given form of business are things which keep down excessive competition and ultimately aid, rather than hinder, the man who keeps trying. The financial rewards from a shoestring venture may not be great; but so long as they are sufficient to maintain life, such a venture is entirely worth-while for the experience, knowledge, and self-reliance it yields.

Those of us in new and untried circumstances are almost necessarily less independent economically than our regularly paid brethren in government employ; but we are permitted to use our imaginations, to develop new ideas, and to wander into new fields, in a manner that is denied the man in routine work. Moreover, the variety of our activities gives rise to a wider variety of experiences and interesting contacts than the routine worker, with his prescribed activity, can know. Of course we pay the price of uncertainty for that freedom. We are, admittedly, gambling; but it is a typically American gamble, based on the development of a new and big thing, with present hardship wagered against future security and pride in achievement.

Young foresters, faced with the problem of unemployment and running the risk of being excluded from their profession, might do well to consider the worth-whileness of the gamble. We younger men will some day have to carry the responsibility of maintaining the progress and the ideals of the profession, and of determining its policies and administering its business. We will have to carry our message into new fields; we'll have to crusade, as the men before us have done, for the extension of the knowledge and high purpose of our profession into every field wherein foresters have a place.

Most of us are determined that we will carry it, successfully, even though it is necessary for us to create our own employment in order to stay in the profession at all. We realize that society needs foresters, particularly in private employ; but we do not expect society to support us unless we can contribute something to it. The continued existence of democratic concepts depends

on the self-reliance of the members of democracy. The task of proving that we younger foresters have that self-reliance is put squarely up to us.

We feel that we have a right to expect some support from the older men in the profession, and from the Society of American Foresters as a group. We do not expect material aid; we only ask for moral support, for an understanding of the problems we face, and recognition for what we are—foresters, in training and spirit.

The writers do not feel that they presume too much in speaking for a considerable number of their contemporaries. We have faith in America, in the profession of forestry, and in ourselves. We think that after a little groping, perhaps, we'll find the right track, and start moving ahead.

That's how we see it.

THE USE OF THE TWO-HAND PRUNING SHEAR IN FOREST PRUNING

By J. G. GEDDES and A. G. ERICKSON

In a previous number of the Journal (36:588-599. 1938) the results obtained with various tools and methods in an experimental pruning of white pine were reported. In that study the California $5\frac{1}{2}$ pt. saw was found to be the most efficient tool for the 0 to 7-foot bole division. The following paper is quite largely a summary of the results and opinions of other workers with respect to the use of the two-hand pruning shear in forest pruning.

Much has been written in the past ten years concerning the cost, value, and recommended methods of forest pruning.

In the earliest days of forest pruning, crude tools and methods were used. The saws and axes were unsuited for the work, and the pruning shears had a dull hook and a very limited capacity. Because of the dull hook, a close, clean cut was almost impossible with this original pruning shear. This defect, plus its limited capacity, practically eliminated its use. Recent improvements and the rapid development of new tools, however, have greatly changed the types in use. Axes are little used at the present time because of the hazard, crude cuts, and also because they cannot be used above the ground. Present day pruning saws are made to cut more freely and rapidly. Some of the new pruning shears have a capacity 50 percent greater than the shears of ten years ago. Furthermore, the greater leverage action of these new shears makes their use less fatiguing; and, therefore, they may be used throughout an entire work period. Moreover, the two sharp cutting blades of these new shears are designed to make clean, close cuts. This improvement is of the utmost importance because it makes available for the first time a single-stroke tool with greater capacity and capable of making a clean cut which is rapidly covered by an entire ring of wound tissue.

In recent years this shear has been tested by a number of professional foresters, including C. H. Coulter, Professor Ralph C. Hawley, Kenneth P. Davis, Basil Wales, and E. M. Simmons.

The following excerpts taken directly from their findings clearly indicate that the attitude towards the use of the pruning shear is rapidly changing. For instance, Hawley states as follows:

"In a recent bulletin setting forth some results of experiments in pruning plantations of pine in southern New England, the hand saw was favored over pruning shears as a pruning tool. This conclusion was reached because the saw resulted in cuts closer to the stem, in less bruising of the tree, and was easier to manipulate in dense clumps of branches than the long-handled (two-handled) shears.

"Recently we have had our attention called to a new pruning shears with which as efficient work can be done in low pruning as with a hand saw. This tool, the Porter Pointcut Pruner, will cut as close to the stem as a saw, does not bruise or otherwise wound the tree, and leaves a smoother cut than the saw. It has handles long enough to give adequate leverage and yet short enough to be manipulated without difficulty in plantations with limbs reaching to the ground. The tool is 20 inches in total length. It has two cutting blades specially designed to eliminate the tendency found in most pruners to creep out on the branch as the cut is made, leaving a stub.

The two sharp blades also avoid the bruising incident to the use of pruner shears with one dull blade."[1]

According to Davis:

"Four types of hand tools were used and time studies made on a number of trees pruned. Results were as follows:

Tool	No. of trees pruned	No. of limbs cut per tree	Time per tree (seconds)	Time per limb cut (seconds)
Saw	10	21.2	184	8.7
Saw	10	28.1	239	8.5
Saw	11	19.3	196	10.1
Shears	10	27.5	140	5.1

"On the basis of time per cut, which is the most accurate comparison in this instance, the Porter Pointcut Pruner was distinctly the fastest tool. The quality of the work was excellent, and the tool is easy to operate."[2]

In analyzing the results of the above test, consideration must be given to the fact that the pruning was done entirely from the ground to a height of about 7½ feet, and on a 25-year-old stand of reproduction.

"The pruning tools used were of two kinds: a pair of heavy pruning shears made by the Porter Company, capable of clipping a limb two inches in diameter. These shears were 30 inches long, built of strong, heavy material and admirably suited to the work for which they were made. The tool has three adjustments, intended to give more leverage as it is needed. The weight was 7 pounds. In the hands of a skilled user, this is one of the most effective tools for low pruning."[3]

Simmons' investigation was made in a twenty-year old plantation, the average estimated height of which was 35 feet, and the average diameter approximately 5 inches. Simmons concluded that forest pruning can be most efficiently carried out under these conditions with a four-man unit by the following procedure:

"Inasmuch as the work was entirely new, a method of attack had to be developed. After trying various combinations, the one upon which I finally decided was as follows: the crew was divided into four-man units; these units worked side by side, but entirely independent of each other, except that each unit was guided upon its neighbor for direction. Thus the work progressed from one side of the plantation, continuously back and forth, to the other. Within each unit, the head man carried one of the Porter tools, with which he clipped all the trees to be pruned to a height of eight feet. This man was followed first by a man with a short-handled saw (10 feet), next by a man with a long-handled saw (16 feet), and finally by an axeman, whose duty it was to cut the trees to be removed, lop and pile the brush.

"As the men became more expert with the tools, it became necessary to readjust these positions somewhat, as circumstances directed. For example, it soon became apparent that the brush pilers had so much more work in comparison that it was impossible for them to keep up. After a bit of experiment, it was found that the head men, with the Porter tools, could clip enough trees by midafternoon to last the saw men the balance of the day. By taking these head men and putting them to help the brush pilers, the work could be kept caught up by the end of the days."[3]

The foregoing statements seem to indicate quite definitely that a pruning shear of proper design is the fastest and most efficient tool for pruning either live or dead limbs to a height of 7 or 8 feet, the usual height of initial pruning in young stands. This height is about as far as a man standing on the ground can reach and effectively use a shear 20 inches long. The second, and the third pruning when it is required, must remove branches above 8 feet. For this work the saw no doubt is the most useful.

Other pruning methods, however, should receive consideration in any forest pruning plan, because a certain method may be more effective under some conditions than others. For example, some people believe that the saw and ladder is the most satisfactory method for pruning above 8 feet. Others, however, believe that this method eventually will be displaced by a relatively new method of impact pruning, which will be described later. In some sections of the country, however, the saw and ladder method is not satisfactory.

Improved pole pruners capable of cutting branches up to 1¼ inch in diameter close enough to meet established forest pruning standards are available in at least two different makes. The

[1]Hawley, R. C. Saw versus pruning shears. Jour. Forestry 33:1009. 1935.

[2]Davis, Kenneth P. Tests of pruning equipment in western white pine. N. Rocky Mt. Forest and Range Exp. Sta. Applied Forestry Notes No. 76.

[3]Simmons, E. M. Pruning and thinning a white pine plantation in the Southern Appalachians. Jour. Forestry 33:519. 1935.

design of these tools has been improved over the old center-cut type with which close, clean cuts could not be made. The maximum branch size for economical forest pruning with pole pruners is still an open question.

The Rich pruning tool is a double-edged impact cutter on a pole. It is designed to sever branches; first by an under and then an over cut. The two cuts thus sever the branch without stripping the tree. This method has the following advantages: it eliminates the need of a ladder, and also saves time. Although this is a new method of pruning and therefore has less background than any of the other methods, it appears to be important enough to justify thorough investigation.

The foregoing discussion is a summary of the findings of professional foresters. Moreover, it seems logical to claim that if the shears now available are as rapid as the pruning saw, and are capable of close, clean, quick-healing cuts, then their single-stroke action must inevitably be less tiring, at least to a man standing on the ground, than the saw with its reciprocating motion.

In further support of the contention that the pruning shear is an important tool for pruning forest trees, it is pertinent to point out that pruning technique in the fruit growing industry is worthy of being examined and of being compared with forest methods.

Fruit tree pruning is an old established practice. As a result of close competition in the industry, the technique has been developed to a high standard of efficiency. Obviously, of course, the technical problems of pruning fruit trees are not identical with those encountered in pruning forest trees. Nevertheless, there are fundamental requirements: clean, close, quick-healing cuts must be made in both instances. The two-hand pruning shear, supplemented by the one-hand pruning shear and to a lesser extent by the pole pruner, plays a very prominent part in fruit-tree pruning. Saws are, of course, universally used, but observation of fruit tree pruning methods in practically all parts of the country justifies the statement that in general the shear is used in preference to the saw for work within the proper capacity range of the shear.

It seems logical to deduce that long experience has taught the fruit grower that for such work the pruning shear, when it is working in its true capacity range, is faster than the saw.

In conclusion, we want to stress the importance of a truly scientific approach to the problem of evaluating equipment for forest pruning. Properly to apply the scientific method calls for: careful planning and execution of tests; intelligent evaluation of all aspects of the problem and consideration of such factors as fatigue, gradual development of skill, durability of equipment, and many others; reliable checks of test results by more extended field comparisons; restraint in drawing conclusions; and above all, it is essential that the investigator refrain from generalizations based on limited test data. Forest pruning is relatively new. Those who are guiding its progress are charged with the important duty of avoiding the serious mistake of trying to standardize methods prematurely.

Woodsmen Go West

THE westward shift of the lumber industry is reflected in a U. S. Forest Service compilation of mill production from 1800 to 1935. Over the entire period the East has supplied more than four-fifths of the American lumber, three-fourths of which was softwoods and one-fourth hardwoods. At present, however, nearly half the lumber cut is from the western softwoods, which include Douglas fir, ponderosa pine, white pines, hemlock, spruce, and redwood. The central region has supplied more than 40 percent of the hardwoods. The cut from 1900 to 1935 was more than half the cut for the previous century, but the mill value for the 35 years was considerably greater than half of the 38 billion dollars which was the total estimated mill value of the cut for the 135 years.

SELECTIVE LOGGING COSTS LESS

By RICHARD DELANEY
U. S. Indian Service

Accelerated by a growing public consciousness for more conservative methods in the harvesting of timber crops, the selective form of cutting has received favorable and valuable publicity. Of necessity public definition of the method has been given in terms of values which might be achieved rather than in terms of problems which must be solved before those values can become realities. That modern methods make possible the solution of those problems at reasonable cost is illustrated by cutting experience upon the Menominee Indian Reservation.

THE importance of proper forest management upon forested Indian reservations is in direct ratio with the fact that the Indian Service problem is, fundamentally, a human problem. For the 230,000-acre Menominee Indian Reservation in Wisconsin this has been given direct expression in the legislative authority[1] which provides, under the direction of the Secretary of the Interior, for the self-supporting tribal operation of a forestry industrial enterprise upon a sustained yield basis. In thirty years of operation this enterprise has provided work for the tribal owners, now numbering 2,200 enrolled members; has yielded returns to the extent of more than $4,500,000 in the form of net income from stumpage and from profits derived from the harvesting and manufacture of 600,000,000 feet of timber; has built up an industrial plant of saw and planing mills and dry kilns valued at over $1,000,000; and has retained a stand of merchantable timber in excess of 600,000,000 feet.

In this accomplishment, in common with any other commercial operation embracing the sustained yield objective, it has been necessary to hold silvicultural practices in that degree of balance dictated by the cost of application. Unfortunately few forested areas, even in northern hardwoods, are so ideally suited to selective logging that application of the method becomes a simple rather than a complicated silvicultural process. In the usual instance, as upon the Menominee, the initial selection operation must deal with a natural stand condition in which overmaturity, species distribution, defect, and other unfavorable factors combine to complicate procedure and to make silviculturally dangerous any practice other than a light cutting premised upon a short cutting cycle.

That light, short-cycled cuttings have now become commercially practical, through the introduction of modern logging methods, is still open to some doubt in the minds of many timber operators. This doubt is understandable. With the logging industry dependent upon a railroad system of transportation, it was generally conceded that the cost of light cutting was prohibitive; and it is only natural that some doubt should now exist as to whether the recent innovation of truck transportation can economically displace the need of cutting more heavily than might be silviculturally desirable in order to liquidate the transportation investment. A comparative cost study of the two methods provides an interesting answer.

The comparison is based upon cost data obtained from an area in which railroad transportation was employed for a three-year period, 1931 to 1933 inclusive, and truck transportation for the one-year 1938. Length of haul was twenty miles. Cutting, to liquidate the railroad, removed 70 percent of the net merchantable volume. With truck transportation only 30 percent of the net merchantable volume was removed. The three years of railroad operation removed 20,058 M feet of timber from 2,000 acres, an average of 10 M feet per acre. The one year of truck operation covered 2,575 acres to produce 10,672 M feet, an average of slightly more than 4 M feet per acre.

Of the two chances the railroad logged area was slightly more compact. Weather influence, degree of utilization, and volume percentages of species logged were similar in both instances. Cull factor, one of the important items in calculation of logging costs, was higher for the light cutting. Horses and tractors were employed for skidding on both types of operation. Wage rates averaged 20 percent higher for the light cutting.

For trucks the area was tapped with a high grade graveled road located on the abandoned

[1]Act of March 8, 1908 (35 Stat. 51).

Fig. 1.—Before cutting. Autumn 1937.

Fig. 2.—After cutting. Autumn 1938. It is easy to visualize a second cutting in ten years. (Note how road scars have healed in one growing season.)

railroad right-of-way. The prorated charge for this road, writing all cost off against the estimated first cut from the areas served, amounted to $0.24 per M. Construction of a thirty-mile network of branch roads, spaced two through a forty to reduce skidding distance, was necessary in developing the area. These cost an average of $100 per mile or a per M cost, including maintenance and snow removal, of $0.47 all of which was charged against the first cut. Modern equipment was employed on road construction.

The improvement value of the old grade, on which the main truck road was constructed, would amount to $0.25 per M; and use of old camp and other improvements would, liberally, amount to about the same figure. These amounts were arbitrarily added to the cost of the truck operation before comparison was made.

Divided into three phases of cost; woods, transportation, and overhead, the light cutting truck operation shows a saving of $1.18, $1.07, and $0.04 respectively for a total of $2.29. The most striking saving is that on woods cost which, although partially accounted for by reduced skidding distance and elimination of draying need, resulted largely from handling only the larger logs. For the light cutting truck operations logs averaged 8 per M, or three less than the 11 per M average for the heavy cutting railroad operation.

In addition to the direct saving in logging costs, the light cutting truck method, in addition to full protection of silvicultural fundamentals, made possible several advantageous moves:

1. Transportation of pulp logs directly to an outside plant without necessity of reloading or transferring to a main line railroad with resultant additional costs.
2. Light cutting of species that would have led to overstocking of inventory under the current market conditions.
3. Coverage of an area in one year instead of in two with resultant saving in old camp and other repair cost.
4. Providing flexibility for supplying logs to sawmill in such manner as to take full advantage of dry kiln and other manufacturing facilities. (The necessity of carrying a large lumber inventory is lessened by ability of a flexible truck logging operation to supply logs of any species or grade almost upon demand.)

Silvicultural application for the truck selection operation was intensive to the point of employing paint rather than axe blazes for the marking of saw strips; was flexible to the extent of aiming toward improvement of the sugar bush chance on acreage so situated as to be of local value for syrup and sugar production. Examining the remaining stand it is easy to visualize a return cutting in ten years that, yielding a higher quality product, will be adaptable to what at that time may be a much improved knowledge of silvicultural practice. It is equally easy to visualize, viewing the road system, a return for salvage cutting, even in limited amount, at whatever time may be necessary.

That, due to road and other improvements, such form of salvage cutting may be conducted at even less cost than the initial operation is illustrated by recoverage, due to an insect infestation, of a 1,150-acre area on which only two growing seasons had elapsed. The area produced 1,225 M feet of timber, an average of a little over 1 M feet per acre. The cost, compared with the regular selection job removing 4 M feet per acre, was $1 per M less.

Aside from road improvements in the area, two important factors contributed to the lower cost of the salvage operation: (1) availability of old skidding trails and landings, and (2) a cull factor so slight as to be negligible.

Yet the salvage job involved a factor of cost worthy of recording since it served to illustrate the advantageous mobility of the truck selection operation. The general economic recession forced a shutdown, in mid-winter, of an operating area supplying species the market could no longer absorb. This left an employment problem that was solved by moving to the salvage area, although the move necessitated snowplowing unused roads and the maintenance of those roads through the wet spring season. This, in turn, resulted in a cost $0.30 per M greater than would have been true had the area been logged during summer months as originally planned. Value obtained by the increased expenditure does not, of course, appear upon the cost ledger.

The examples recorded are only a part of a single year's operation. They are consistent, however, with the findings of three years of truck selection and salvage operations covering 21,000 acres of area and producing 80,000,000 board feet of logs.

The general appearance of an area before and after selective logging is shown in Figures 1 and 2.

TOWN FORESTS IN NEW HAMPSHIRE[1]

By WARREN F. HALE

New Hampshire Forestry and Recreation Department

In New Hampshire, some town forests date back to Revolutionary days. For over one hundred and fifty years these forests have been producing forest products and an appreciable income for the towns. It is indeed not necessary to go to Germany for illustrations of successful town forests—all that one has to do is to go to New Hampshire.

TOWN forests were acquired in New Hampshire at an early date and many records concerning their development and management have been kept. The New Hampshire Forestry Department was organized in 1909; at that time 25 towns owned town forests and had managed them for many generations. The oldest town forest in New Hampshire is believed to be in Newington which built its church in 1710 on town-owned land. The towns of Danville, Newington, and Grantham have held some of their lands from Revolutionary times.

Town proprietors first selected timber lots for themselves; then usually set aside a lot for the support of the minister as well as a lot for schools. All the remaining unallotted lands were held by the first proprietors and were to be used by the settlers as needed. Timber and wood were cut at an early date from these lands. Some towns in New Hampshire today still retain some of these unallotted lands. A few towns bought farms during the early part of the past century for the maintenance and support of the poor and still possess the forest growth on these tracts. Town forests have been recently acquired by defaulted taxes, by purchase, and by gifts as memorials by interested citizens. Some towns have appropriated funds and purchased forest lands for growing timber. Other towns unfortunately have sold all the standing timber and have done nothing since. Eight of the ten cities in New Hampshire own forest land for water supply and park purposes.

In 1913 the New Hampshire legislature passed a law requiring towns which purchase forest lands to manage them under the direction of the state forester. The forestry department has always been eager and willing to assist the towns in the care and management of their forest lands. The state forester and his agents have frequently been consulted in regard to the making out of deeds, the proper marking of boundaries and surveys, the cutting and sale of wood and timber, planting, and general advice in the handling of forest land. For many years the department has given reforestation stock free to towns which plant on town forest land. With increased interest in forestry, the acquisition of town forests in New Hampshire seems to be developing and a brief description of a few town forests therefore may be of general interest.

Newington.—This community has the oldest town owned forest in New Hampshire. The present area of 112 acres lies mostly on the main highway leading from Greenland to Dover and on both sides of a new road from Newington to Portsmouth laid out in 1896. Within these boundaries are the church built in 1710 which the town has always owned, the library, town hall, a new school, and the old parsonage. At a town meeting in March 1765, the voters decided to buy a 20-acre farm for a parsonage and support of the minister of the gospel. During the next century the different boards of selectmen managed this tract, giving fuel to the town poor and allowing citizens to cut from it their winter supply of wood. In 1874 it was voted to cut and sell the growth on the tract which the town had purchased in 1765, but the Congregational Association of Newington, organized in 1862, protested as it claimed the church owned the land and growth. The dispute was later settled in favor of the town.

The selectmen in 1892 decided to sell some of this timber which gave the town a profit of $1,500. This fund helped build the new library. In 1912 the town voted to install a water system

[1]This article was written just before the hurricane of September 21, 1938, which explains why there is no mention of the damage sustained from the storm by many of the town forests in New Hampshire. At Sunapee the big trees, known as the "Dewey woods," were badly damaged. Portions of the town forest at Warner were also blown down. Several of the towns have already salvaged their timber and are clearing up the slash; others are expected to begin this work within a short time. It is possible that assistance may be given to some of the towns by the U. S. Forest Service and the State of New Hampshire.

in the town buildings and a drinking fountain at the square. More timber was cut and sold, the proceeds used to pay these bills, and $700 was turned over to the town treasurer. Again in 1919 two small areas of growth located on each side of the new road were sold with a profit to the town of several hundred dollars which was kept in the treasury until the new school house was built in 1920.

Newington has held and managed a 30-acre tract of woodland since Revolutionary days. No records of cuttings on this lot are noted until 1874 when the town voted to sell at auction 12 two-acre lots. The highest bidders hired a portable mill, the first in Newington, to do the sawing. The average sale from each lot was about $200. This fund was used to pay off the Civil War debt. In 1915 the town planted 10,000 white pines on the old parsonage lot, the trees being donated by an interested citizen of the town. In 1919 the growth on the remaining six acres of the lot was sold. In 1922 about 200 cords of wood were sold on the stump for $2.50 per cord. During the past fifty years the town has voted to sell timber from the forest which has resulted in receipts of over $6,000. In spite of heavy sales the area is now covered with a good stand of young pine and clumps of merchantable timber.

Danville.—One of the first town meetings in Hawke, later Danville, was held in March 1760 to elect officers and to act on the town warrant. From the old records we find: "To see how much money you will raise for Priching (preaching) the present year." It was voted that there should be "Five Hundred Pounds Old Tenor Raised for Priching." From the vote taken it can be seen that the support of the ministry was put first among the duties of the parish. At a later meeting it was voted to set aside a 55-acre lot for the use of the parish and shortly afterwards a 22-acre piece was set off for the use of the minister. The same year the people decided to build a meeting house and the timbers were cut and hewn from the 55-acre lot.

About the year 1790 we find in the records that a parsonage committee was appointed to care for the parish lots. It seems probable that similar committees have served the parish since that date as there exists today a parsonage committee of three men. The committees annually made a report on town meeting day showing the receipts from wood and timber, rent from pastures, and receipts from hay, rye, and other grains.

In 1830 the receipts were $180; in 1835 the amount was $214. Small receipts totalling over $1,000 for rentals are shown until 1880. In 1863 the committee sold some pine stumpage on the big lot and reported $1,406 for the year. All receipts were deposited immediately in a bank after paying small sums to the minister. Probably much of the primeval growth on the 55-acre lot was removed, as the receipts were small until another crop of pine matured in 1895. The committee sold part of the mature timber and realized $1,975. In 1902 the committee made its greatest sale when $4,500 was received from wood and timber on the 55-acre piece. The early harvest of the pine was composed of the big primeval growth; boards in the old meeting house have a width of 24 to 30 inches. The hewn timbers likewise show they were cut from old-growth pine. In 1903, about $1,200 was received from the sale of wood and timber on the 22-acre lot. The report of the parsonage committee for the year 1938 shows a total of $9,662 deposited in banks with interest of about $305 which was used in part payment to help pay the salary of the community minister. In this report is an article: "To see how much of the Parsonage funds the Town will vote to spend for preaching for the year ensuing."

We have then by these many reports a continuous record over a period of 178 years, 1760-1938, of a town asking its citizens how much money they will vote for the year in part payment for their community minister from a fund raised from the town forest and managed by a town forest committee. Danville has acquired during the past ten years about 200 acres of forest land by defaulted taxes. These lands are located adjacent to the old parsonage lot and include a valuable growth of pine and hardwoods.

Milton.—In 1839 the town of Milton purchased a farm of 140 acres, located in the northern part of the town, for the care of the poor. During the next 30 years those needing help and having no home resided on the farm. No records are available giving the date of cutting of the old growth on the lot, but in recent years the town has received considerable revenue from the sale of wood and timber, a total of about $13,000. It has been estimated that there is now over 200 M board feet of merchantable timber. The money from the sales has been used by the town for building sidewalks, for improvements to roads, and for town buildings.

Warner.—The town of Warner in 1929 re-

ceived a gift of 804 acres of forest land comprising the wooded slopes of the Mink Hills located only a few miles from the village. The deed of gift included a clause giving the state forester authority to supervise the cutting of the growth. A town forest committee was appointed to assist the selectmen in the management of the forest. Several hundred cords of poor grade wood were later cut and used in the schools, the town house, and the library. The receipts from sales of wood and timber were put into a continuous fund and used for improvements on the forest. A type map was made showing the location and volumes of different kinds of growth.

The only hardwood distillation plant of its kind in New England is located within a short distance of the forest and has provided a market for much of the hardwoods. Contracts for hundreds of cords of wood have been given the town by this plant. Although the net receipts have not been great, the orders have provided work for the town unemployed during the winter months. The gross sales since the forest has been establishd are over $11,000. This forest fund has not had an opportunity to increase greatly because of the heavy demands made upon it at town meeting day. The town forest committee has not been able to check the voting of funds for other town needs. The last town report states that there is cash on hand amounting to $906; accounts due $285; cut wood and lumber on the forest estimated at $516; making total assets of $1,707. An effort was recently made to have the state forester approve the cutting by a lumber operator of about 500 M of spruce and pine on the forest, but after a careful study it was decided that no clear cutting should be done at the present low stumpage rates. More than 50,000 trees have been planted by the town.

Within the past few years Warner has been obliged to acquire by defaulted taxes 365 acres of forest land adjacent. The total acreage is now 1,169 acres valued by the town at $15,000. The town forest committee is always pleased to show visitors about the forest.

Sunapee.—The town of Sunapee owns a fine stand of timber. The tract of 100 acres is located just north of Sunapee Harbor near the lake shore and promises recreational value in addition to its valuable timber. The land was acquired in 1928 by cooperative effort through contributions by generous citizens of Sunapee, by a direct vote of the town appropriating funds and by a gift from the Society for Protection of New Hampshire Forests. This effort by the people of Sunapee is an excellent example of acquiring a town forest, the estimated valuation of which is $6,000.

Grantham.—The town of Grantham was given a charter about the year 1800. It was customary for the proprietors to allot one 100-acre lot for the support of the minister and one lot for the schools. For many years timber was cut and given for these purposes. The townspeople gradually lost interest in these lands as they were located on distant Grantham Mountain and were rather inaccessible. The minister got his wood nearer home and the schools had appropriations for their use made at town meeting. Few people realized that these two lots still existed.

Several years ago lumbering began on Grantham Mountain adjacent to the town's lands and several interested citizens insisted that some of the timber on the minister's lot had been cut and removed. A surveyor was hired to look up the old deed and search the town records. It was found that the town had never sold or parted with these lots. After careful surveying with the assistance of the selectmen, some of the original corners were located. There was no doubt that much of the best timber had been cut. The lumber operators were asked to check the deeds and surveys which proved to be correct and later a settlement to the town was made for $1,100.

The town estimates that the value of the timber still uncut is $3,000. Grantham can rest assured that no further attempts will be made by lumber operators to cut timber adjacent to the town lots without due care.

In order to ascertain the latest information about town forests in New Hampshire, the Forestry and Recreation Department sent out a questionnaire to all towns on April 1, 1938. Of the 221 towns in the state receiving this questionnaire, valuable information has been received from 180. One hundred twenty-eight towns reported having town forests. Parks, commons, and cemeteries were not considered. Sixty-seven towns declared that they had acquired forest land by defaulted taxes since 1932 and the deeds had been recorded. Many of the town reports indicate that the total acreage was divided into numerous separate tracts. Some towns had acquired forest property of much value; others were holding cutover or slash lots of little value. A few of the towns felt that the state should acquire title; other towns were not concerned about this problem. The 128 towns having forest land

report a total acreage of 32,000 acres or about 250 acres per town. The valuation was returned as approximately $500,000. This high valuation is probably due to many of the towns having valuable water supply forests. One town reported that it had acquired 3,580 acres for a water supply costing $45,000.

It is expected that the towns which have owned forest lands over a long period of years will retain them; that towns recently acquiring title will endeavor to put them to good use by accepting free reforestation stock from the state if planting is necessary. Towns using wood for fuel in schools should put the able unemployed to work improving the forest. The state will continue to assist the towns in the development and management of their lands in every way possible. There are possibilities that many of the towns may assume real activity in forest management with increased stumpage and markets.

THE SLAB PILE AND LOGGING WASTE

By J. ALFRED HALL

California Forest and Range Experiment Station

Management of lands from which timber is the principal return is supposed to deal with the methods of producing and marketing a tree crop that will return continuous profit to ownership. It is required, therefore, that on such land species, sizes, and qualities be produced for which a market can be found at prices for stumpage that will return a fair earning to the land. If the result is otherwise, ownership becomes bankrupt and land changes owners until a price level for land is reached at which the interaction of market and growth capacity can return a profit. It is to be noted that in spite of all recognized attendant social values of such forest land, stumpage returns only are available to meet the costs of ownership and management. American multiple use management, whether the principal objective is watershed protection or recreational use, cannot ignore the cognate values derivable from sales of stumpage. Where wood is to be grown anyway in following such objectives, it might as well be good wood.

STUMPAGE values, in a general way, are determined merely by the interplay of the wood market and the supply of available stumpage. The wood market is a vast complex ranging from firewood to the highest quality of veneer wood; hence stumpage returns are enormously variable according to the use value, supply, and location of wood for specific purposes.

Forest management has a certain latitude of choice in its policies, limited by natural factors, and guided by future economic factors in so far as they can be foreseen. It aims definitely, however, at securing the maximum possible stumpage returns to lands managed principally for timber production, provided the so-called "social values" are met. The incident of land ownership being combined with ownership of a converting agency, whether sawmill or pulpmill, does not alter the nature of the return on land valuation. Forestry must take cognizance of stumpage returns as distinguished from conversion returns.

This paper is intended to discuss certain phases of long range management that appear to the author in the light of the above discussion as fallacious or at least questionable.

Present and Future Stumpage Market

There has never been a real stumpage market in this country based on the cost of growing timber for the simple reason that there has always been a huge reservoir of virgin timber. As long as that reservoir exists, burdened with the economic evils of long past speculative investment, there can be no real basis of stumpage valuation. Local second-growth lumber is still in competition with virgin lumber from distressed stumpage, sold on the market at prices far below those which it should normally bring if due regard were had for the costs of growing the next crop. The next crop, therefore, over much territory will be whatever nature permits to grow when no real management policies are invoked beyond those required to convert existing stumpage at an operating profit.

The future market for stumpage of good quality will undoubtedly be much higher than the present fictitious market; how high it may be cannot be foreseen because it will result from the changed market created by the exhaustion of high quality virgin timber, and the degree of utilization of second-growth timber. The use value of such wood as compared to our present most valuable species, is yet to be determined and will be determined by the forest management policies invoked within this generation as well as

by the development of better methods of utilization.

A Few Management Problems

Laissez faire management has brought the following results:

(1) Southern pine—rapid second growth capable of a quick rotation, producing saw timber of probable low use value unless growth rate is well controlled by proper stocking. Intermediate cuttings must find a market and pay thinning costs if good saw timber is to be grown.

(2) Eastern white pine belt—beech, birch, maple, and hemlock replace white pine.

(3) Lake States—white pine is replaced by aspen and jack pine.

(4) Inland Empire—white pine is replaced by larch and lodgepole pine.

(5) Douglas fir region—virgin stands of Douglas fir converted to hemlock.

(6) California—ponderosa pine replaced by white fir and incense cedar. Redwood replaced by white fir and Douglas fir when allowed to survive.

These are but a few examples of the general tendency toward second-growth stands of degraded use value. Future stumpage values, measured in terms of saw timber, cannot fail to reflect the lowered use value of the lumber produced from such stands.

The public and some foresters are easily satisfied. A green cover on the mountain side satisfies their cravings to keep something growing on the land, but hard economics demands that the land produce value. The crops of trees growing on too much cutover land will have so low a conversion value that land will receive little returns, except those arising from recreational values. Weak, brash, nondurable lumber will never command the market now held by virgin qualities. The market is still a good market and can continue good as long as lumber of good quality is supplied.

We now use about 185 board feet of lumber per capita per year, even in years that are not considered so very prosperous. Over eighty percent of all our people are housed in wood. They will continue to be housed in wood as long as it is the most economical and satisfactory building material to use. But, let the lumber market be confined to the species now growing on converted stands, and that market will be taken by substitute materials. Wood is not passing out; it will not pass out as long as it remains satisfactory. A nation withdrawing from its forests for all uses around the equivalent of 400 board feet per capita per year obviously needs wood and will use it. Forest management must meet that need, and must meet it with material for which it can obtain sufficient reward to make forestry pay.

Foresters recognize these things but are, to a degree, lulled by hoped-for miracles. They have seen the enormous rise of the various fiber boards and paper products; they have seen the vast expansion of the cellulose using industries; they have visualized the forest of the future as a producer of cellulose, a reservoir of raw materials for chemical industry, which will save them the immense trouble of growing saw timber. Possibly the future forest will produce much chemical raw material, but stumpage returns are meager from such sources.

The major returns to most forest land must come from saw timber. The use value of wood in construction does not depend upon its cellulose content. It is strong and light, tough and resilient, because it grew that way. Its fibers are oriented as parallel tubes, bound together in such a way that its strength properties across the grain are far different from those parallel to the grain. It is a very simple matter to disintegrate wood and reassemble the fibers into a so-called synthetic board in which the one bad quality of wood has been overcome, namely, lateral shrinkage. But, the strength properties of the resultant board will be much the same in any direction and much lower than in wood. Those properties that make wood valuable for most purposes have been lost because the fibers are no longer oriented. One cannot yet conceive of a "synthetic" bridge timber or rafter, although there are perfectly definite and satisfactory uses for "synthetic boards."

However great the future improvements may be in wood distintegration and reassembly of the fibers, the returns in stumpage are not likely to be great. The costs of such enterprises are mostly conversion costs and the raw material must be cheap. The cost to the consumer is usually higher than for any equivalent quantity of lumber.

Why should the forester grow wood of poor quality, sell it cheap to a converting agency, and enable the production of a product that unsatisfactorily replaces the good wood that the forester could have grown for a good price? Why not grow good wood, take a part of the excessive conversion cost of the "synthetic board" as stumpage value, and continue supplying good lumber to a public that wants it? There is obviously quite a difference in returns to the land from stumpage at 50 cents a cord and $4 a thousand. If the market demanded the product yielding 50 cents

stumpage to the exclusion of lumber at $4 a thousand stumpage, management would have no choice; it would grow just wood. But the lumber market exists, and will continue if fed good lumber. Thinnings and logging and milling waste can supply the wood fiber board market.

Chemistry works wonders but it does not make wood. Nature does that out of sunshine, water, and fresh air and she does it rather cheaply and well. Cellulose is only a part of wood, a very important part and valuable. We often tell ourselves that our forests are cellulose factories and that future chemical marvels will use it all. It will not make any difference whether it is ponderosa pine or white fir, white pine or larch, chemistry will convert it to valuable products, and foresters will be saved the trouble of growing sawlogs. Let us examine the conceivable cellulose market, and see how big it is, how much competition there may be, and, above all, what returns in stumpage value we may expect from it.

Paper.—At present we use paper equivalent to about 87.5 board feet of lumber per capita per year or less than half of our lumber consumption. Stumpage varies, but 50 cents to $1 per cord for pulpwood is about the range. Since a cord is roughly equivalent to about 500 board feet, $1 to $2 a thousand is about what we may expect for stumpage. It is not likely to be more if we try to turn everything growing in the forest toward pulp; it is much more likely to be less. Furthermore, processes are in development that are less critical of wood qualities than present processes. The future pulp mill may very well use logging and milling waste without much sorting so why should the forester aim at growing only raw material for pulp when he can very well grow valuable saw timber and let the pulp mill have the inevitable waste? The present waste in the slab pile is more than enough to supply our whole pulp needs. Its returns to conversion will lessen the economic burden on the sawmill and leave more latitude for stumpage returns to saw timber.

It will probably be increasingly true that wood cellulose will find competition in cheap cellulose from agricultural wastes. There would seem to be small logic in directing general forest management policies to meet such competition with a main crop of wood fit for nothing but pulp.

Textiles.—Chemists make much, sometimes, of the fact of the conversion of wood cellulose to rayon. The total estimated rayon production in 1938, 400,000,000 pounds, is equivalent to about 300,000 tons of pulp or 300,000,000 board feet of lumber. This amounts roughly to about 2.3 board feet of lumber per capita.

If we produced cellulose enough from wood to replace the entire cotton crop, about 2,000,000 tons, we would consume about 5,000,000 tons of pulp, or 5,000,000,000 board feet equivalent of lumber. This incomprehensible task would net a consumption of wood equivalent to 38.5 board feet per capita per year, about what we use in crossties.

Sugar.—Germany, hard pressed, produces much glucose from wood hydrolysis. She uses it in part as a medium for yeast fermentation and achieves cheap conversion of ammonium sulfate to protein, feeds that in a proper mixture, and grows meat on an original wood products diet. If we conceive a major agricultural revolution and consider growing all our sugar as well as cotton as wood cellulose we get the following figures. We consume about 102 pounds of sugar per capita per year, equivalent to about 92 pounds of cellulose. That much cellulose is contained in about 140 pounds of pulp, equivalent to about 70 board feet of lumber.

Alcohol.—We are told that eventually we may substitute about 10 percent of our gasoline with alcohol produced by the fermentation of glucose. On our present gasoline consumption of 500,000,000 barrels of 42 gallons, that will require 50,000,000 barrels or about 13,650,000,000 pounds of alcohol. Roughly, we get one pound of alcohol from two pounds of sugar. This figures back to 16,250,000,000 board feet of lumber equivalent or about 125 board feet per capita.

Note, please, that all these products require cellulose, not wood. Cellulose may be bagasse, cornstalks, cotton stalks, or a lot of other things. Wood, to be of any use to these industries, will have to be cheap wood. Cheap wood does not pay high stumpage prices. Lumber does.

The products discussed add up to 321 board feet per capita per year. The total is only 136 board feet above the present lumber consumption. In short, the waste from the harvesting and manufacture of the lumber normally required by this country plus silvicultural thinnings and forest waste from all other products is capable of furnishing enough raw material for any cellulose requirement reasonably in prospect. Such wood can be cheap. Most of it costs money to bring to the mill. Any return to the converting industry could be profit, part of which can return to stumpage.

The big margin of stumpage return, however, would continue to be from high quality timber as it must be if forestry is to pay. Give the chemist the slab pile and the stuff now left in the woods. Foresters must grow sawlogs.

SERVICING FIRE CREWS BY AIRPLANE

By J. F. CAMPBELL
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About twenty years ago when the use of airplanes in fire location and patrol was proposed, the idea was considered to be visionary. Today fire crews working in inaccessible areas are serviced by the airplanes. The possibilities and limitations of the method are described in the following article, the author of which has had broad experience in forest protection work. *Servicing Fire Crews by Airplane* may, therefore, be regarded as an up-to-the-minute, authoritative discussion of the use of airplanes in servicing fire crews.

DEVELOPMENT of the retarder method of delivering supplies to fire crews by airplane was undertaken in the Northwest in 1936. Prior to that time much important work had been done by the late Howard Flint and others in national forests in Region 1, and by Henry Shank in Region 4. Most of this work was with the tight package and with the loose package or bean bag method of packing. In both cases, packages were dropped without chutes or retarders. Experience in the Northern Cascade Mountains with the tight package method where supplies were dropped from an elevation of 800 to 2,000 feet was very discouraging. Supplies and equipment dropped from these heights were so severely damaged as to be almost unusable. The loose package method seemed to offer much greater promise. Tools and various kinds of food supplies were dropped from heights of from 400 to 2,000 feet and the damage found to be much less severe.

While these tests were being carried on, it was noticed that when a number of loose packages were tied together tandem or in clusters, they descended more slowly than when dropped singly. This suggested the idea of using retarders or chutes. As a result of these preliminary tests, Wernstedt[1] was assigned to study the possibilities of the retarder method. He was instructed that chutes must be cheap, made of materials readily available locally, and quickly made. The method reported in *Fire Control Notes,* April 1937, was the result of Wernstedt's work. Briefly: chutes made of sheets of burlap about 7 by 7 feet with shroud lines 17 feet long made of No. 7 sash cord were used. The shrouds were attached to the four corners of the burlap by tying them around blocks of wood about 1 by 2 by 4 inches over which the tips of the burlap had been folded. The chutes and shrouds were then folded and rolled in such a way as to open when thrown from the plane. The package to be delivered was attached to the loose ends of the shrouds.

All kinds of supplies and tools were successfully dropped, and losses due to breakage were relatively small. Special packaging was found to be necessary for some kinds of materials and equipment. Canned goods were taken from the original case and placed between two octagonal pieces of plywood and then bound with small Manila rope. Glass goods, eggs, radio instruments, and similar fragile items were padded with loaves of bread. It was found that sliced white bread was best for this purpose. It can be used for food after it has served its purpose as shock absorber. Unsliced white, and dark breads shatter badly and do not seem to be so effective.

Packages of ordinary supplies or equipment weighing up to 50 pounds were dropped without damage with one chute. Fragile items such as radio instruments and packages weighing much more than 50 pounds required two or more chutes. When more than one chute was used, they were attached cluster fashion, but were found to work quite as well tandem.

Several makes of plane were used. These included Fairchild, Travelaire, Fokker, and Bellanco. In general, the ships must be high wing monoplanes with the door behind the wing braces and must have high flying tail surfaces in order to clear packages and chutes.

The door is removed from the ship and the dropper is tied to a fuselage brace on the opposite side of the plane by means of a telephone lineman's safety belt. He is thus able to lean out the door with safety to locate the target and to shove the bundles clear of the plane (Fig. 1).

During the spring of 1937, eleven men from the national forests of Oregon, one from the staff of the Oregon state forester, and eight from

[1] Lage Wernstedt, topographic engineer, R-6, U. S. Forest Service.

Fig. 1.—Upper left, handling cross-cut saws in 'plane. Upper right, shovels parachute with streamer coming down. Lower left, supplies leaving 'plane. Lower right, milk can after landing.

Washington were trained as droppers. The men became quite proficient in making and folding chutes, preparing packages, and dropping them accurately during the five-day training course.

Before the opening of the 1937 fire season, forest supervisors prepared maps showing areas so inaccessible by truck and pack animal as to make the use of air transportation advisable. These map plans were conservative and quite simple, but they served to stimulate an air consciousness.

Late in August 1937, a serious fire occurred on the Wallowa National Forest. To reach this fire required a 62-mile truck trip over a road much of which was rough and slow. From the end of the road to the nearest point on the fire was about eight miles; the difference in elevation was three thousand feet. Moving supplies and equipment by truck and pack horse would have been a slow, exhausting job. Moreover, a sufficient number of pack animals to deliver adequate supplies was not available.

Two planes were employed to fly supplies and equipment for a crew of 425 men. In addition, hay and grain for 50 head of saddle and pack horses were transported from the town of Enterprise to the dropping field at the fire, an air distance of about 28 miles.

During the ten-day period required for corral and mopup of this fire, approximately 60 tons of materials were transported. Losses were not much heavier than might have been expected had trucks and pack animals been used in place of the planes; the saving in time much more than offset these losses.

On the Wallowa fire, an opening in the timber possibly 10 acres in extent was used as a central dropping place. Materials were packed by horse to the three camps but in no case was this pack more than one mile. Another advantage gained in this instance was that many of the 50 horses on the fire were made available to pack water for back pack pumps, and for saddle horses for overhead on the fire itself.

Costs on this fire were increased by an unsatisfactory landing field at the supply base. This, together with the fact that the elevation was fairly high, limited the loading to an average of not over 600 pounds. Even so, costs were but little higher than trucking and packing if the cost of bringing in a sufficient number of pack animals were included.

Air Transport Planning

During the winter of 1937-8, the air transportation plans and specifications for the national forests of Region 6 were overhauled. In the light of the experience gained on the fires of 1937 it seemed advisable further to encourage this mode of transportation. Accordingly, the supervisors were instructed to prepare new maps showing by color symbol all areas which it was estimated would require more than six hours travel time by truck and pack animal combined. The six-hour interval was selected arbitrarily in order to secure uniformity in the planning. It was estimated that, on the average, planes could be secured, loaded, and flown over a camp anywhere in the Region in that length of time. Subsequent experience has shown that this cannot always be done because of the scarcity of suitable airplanes. Especially is this true after the first two or three planes have been employed. Landing fields, lakes large enough for landing seaplanes, and emergency landing fields were also shown on the map.

The instructions stated clearly that the airplane maps were to be used only as guides and that forest supervisors should take the use of aircraft into consideration when planning attack on any fire reported in the mapped areas. It was recognized that a number of factors other than elapsed time should enter into the decision. The following were listed in the instructions:

1. Number of men to be supplied. (If the crew is small, back-packing may be the better method.)

2. Condition of trails. Some trails may be dangerous for horses, especially when traffic is heavy, and airplanes may be needed at least temporarily to supplement the usual means of transportation.

3. Need for speeding up initial deliveries. Where an airplane can be obtained quickly, it may be desirable to use it for early deliveries, and then to discontinue its use and supply the crews by means of trucks and pack trains.

4. Need for establishing camps on the fire line. By using airplanes it may be possible to establish camps closer to the fire line than could be done otherwise, thus saving the men considerable walking time and fatigue.

5. Urgent need for available pack stock to pack water for back-pack pumps or to pack other equipment from point to point on the fire.

In July 1938, the method was used on a large

scale by the State of Oregon in fighting the disastrous Smith River fire. Two ships were used over a period of two weeks. These planes were a Fokker universal and a Fairchild monoplane. About 80 tons were delivered, and a strong crew was maintained on the fire where it was impossible to supply them with pack animals.

During the serious fire situation on the Siskiyou Forest in July and August 1938, planes were used. At the height of this campaign four large fires were burning in the inaccessible interior of the forest. Altogether there were 50 camps with a total of 4,500 men to be supplied. All available trucks and pack horses were mustered into service—man back-packing was resorted to, but still without the three freight planes the transportation job would have bogged down utterly and crews would have had to be withdrawn for lack of food. Two Fokkers of 1,200 pounds payload capacity and a Travelaire of 800 pounds payload were used, and altogether 112 tons of supplies and equipment were delivered to fire camps. Six camps on two fires remote from roads and trails were serviced entirely by plane and supplemental deliveries made to many other camps. Losses were low. The most serious of these were due to carelessness and imperfections on the part of warehouse packers and those making and rolling chutes. A number of packages broke away from the chutes and were demolished. Several chutes failed to open due to carelessness in folding and rolling. In one or two instances, droppers neglected to remove a rubber band placed around the rolled chute to hold it in the roll. These chutes, of course, failed to open and the cargoes were damaged.

The most serious difficulty was encountered when the planes were grounded for three days by low visibility due to smoke. When it is remembered that several hundred men were entirely dependent on the planes for their food, the serious nature of this visibility problem can be more readily appreciated. During the three-day period referred to, the men went on short rations but they stuck it out. When flying was resumed, every effort was made to establish a surplus in the camps to provide against another smoky period. However, planes were not again grounded for periods of more than an hour or two.

In the case of the Siskiyou fire, practically all the flying was done from a Forest Service field at Gasquet, Calif., which had been completed only about a month before the serious lightning fires occurred.

During these operations on the Wallowa and Siskiyou fires, many things were learned. Most of them had to do with the organization required to handle the special transportation job. Another important problem was lack of planes suitable for the job of dropping supplies. It was found that there are not more than four or six commercial planes in Oregon and Washington which are of proper design, capacity, in good condition, and available for this kind of work. At the time of the Siskiyou fires, two of these were employed on the Smith River fire, and therefore were not available. The natural implication of this situation is that if the fire protection agencies intend to use airplanes on a large scale they should immediately begin to acquire suitable ships. However, this does not appear to be true because the need for airplanes is quite likely to peak during a very brief period and then disappear entirely until the next season. For example, on the Siskiyou Forest in 1938 several airplanes were imperatively needed at the same time. Even though the Forest Service had owned one large and very satisfactory ship it would not have served the purpose and yet the cost of the plane, the salary of the pilot, the fuel, oil, and other service charges for just the one ship would have equalled or exceeded the rental charges for all of the ships used. To those of us who have had experience with the method, the chartering of privately owned ships seems to be the best solution at least for the present. The possibilities of this type of charter work have attracted considerable attention in commercial aviation circles and it is quite probable that by another season the number of suitable ships will be increased.

Organization of Delivery Service

Although Wernstedt found that almost any kind of foodstuffs or equipment can be successfully delivered to the fire camps, we now realize that it is good business to restrict the list.

On the Wallowa fire in 1937, the airplanes transported whatever supplies the Army officers turned over for the use of the C.C.C. crews on the fire. Naturally, much of this material was bulky and of relatively low nutritive value per unit of weight. The arrangement there worked fairly well because the flight distance was short and visibility conditions excellent throughout the project. Furthermore, the number of men to be fed was comparatively small (425 including overhead) for two planes. Men handling the work considered the advantage of especially prepared

ration lists and packages, but realized that losses in elapsed time and extra costs for noncontract packages can easily exceed savings in cost of flying time. So as long as the flying facilities were adequate, no acute problem developed.

On the Siskiyou fires in 1938, however, the situation was different. In this case, distances from the landing field to fire camps was greater, visibility conditions seriously reduced daily flying time, and an adequate number of planes could not be secured during the early stages of the job. Here again forest officers began by transporting practically any kind of food supplies furnished by the Army or ordered by civilian cooks. It soon became evident that something drastic would have to be done, because not enough items of substantial food value were being furnished to the men.

As soon as the necessary movements of men could be effected, C.C.C. crews were withdrawn from all camps to be supplied by plane. These crews were replaced with civilians, and orders were given the man in charge of air transportations that only foods of high nutritive value per unit of weight should thereafter be transported. Thereupon a special ration was developed and used almost exclusively throughout the remainder of the job. Orders from fire-camp cooks for special items were filled only if and when room and weight capacity were available in the ships over and above the regular ration requirements. After this arrangement was put into effect, not many complaints of shortage of food were reported.

The Ground Crew

This experience pointed to the need of a qualified steward to supervise the purchasing and distribution of rations. The job becomes more than one of merely purchasing supplies ordered by the camp cooks. It involves planning an iron ration which will satisfy the needs of men working under the most trying conditions. On projects as large as the one under discussion, it will probably always be desirable to employ a steward. However, airplane ration lists are now being worked out for use next season. Such lists will have to include an adequate variety to satisfy the men and yet limit the water content to a minimum. The services of expert dieticians is necessary in this phase of the job. When properly balanced standard ration lists have been worked out, they should be of great value on small or comparatively small fires.

Under such conditions of visibility as were encountered on the Siskiyou, planes sometimes took off with a load but returned without delivering it. These failures were due to local smoke blankets which obscured the target so that the flight crew could not see where to drop the load. These unsuccessful flights are expensive and their numbers must be held to a minimum.

Where more than one plane is serving a camp, take-offs must be carefully scheduled so that the first ship will have completed its circling and dropping before the second arrives over the camp area. Unless this is done, costly and useless flying time will be consumed by the second ship in awaiting the unloading of the first.

Loading cannot be left entirely to the pilots. There are two main reasons for this. First, the nature of the terrain makes flying hazardous; the lighter the load, the greater is the gliding range and consequently the greater the margin of safety. Whether or not consciously done on the part of the pilot, there is the tendency somewhat to underload the rated capacity of the ship. This increases costs. Second, where a package or two must be left behind, pilots are not in a good position to determine what can be left with the least sacrifice to the fire fighting forces.

Pilots should be on the job early in the morning for frequently the haze is lighter then, and there may be time for two or three flights before visibility conditions become bad. Some pilots are ultra conservative and seize upon almost any excuse to postpone a flight; others may be too daring, and willing to take too many chances.

Many things in connection with the maintenance of the field and servicing the planes must be handled. When two or more planes are used, and particularly when the landing field is not surfaced with sod or asphalt, a ground crew of several men is required. The duties of this crew include refueling the ships, dampening down the runway to lay the dust, keeping at least one load ahead at the field, helping load the cargoes, and many other similar activities. It is important that no delay in take-off be occasioned by any of these factors when flying conditions are favorable. When this crew exceeds three or four men, it should be under the immediate direction of a foreman or boss who reports directly to the dispatcher.

The need for a highly competent dispatcher on large operations is evident. This man should have a good grounding in aeronautics, although he should be primarily a forester. At least he must have a thorough understanding of the needs

and requirements on the fire. His knowledge of aeronautics is necessary to enable him to judge when flights can be successfully completed and when it is inadvisable to permit ships to take off. He must be able to judge the correctness of the contentions of pilots as to load limits, visibility, wind conditions, and like matters. His knowledge of forestry practice is needed to enable him to take advantage of the lookout system, the haze meter, the wind gauge and vane at forest fire danger stations, the telephone system, and the radio nets to assemble information on local flying conditions. He should also be able to judge accurately the most critical needs as between the various items to be transported.

Working under the general supervision of the steward, one or more packers are required to prepare the chutes and bundles. Their number, of course, depends upon the volume of material to be moved. On jobs such as those on the Wallowa and Siskiyou National Forests, these crews ranged from four to nine men; and on the Siskiyou, night shifts were necessary.

Where several packers are employed, their work must be directed by a foreman or boss. In addition to supervising the work of others, it is this man's responsibility to see that packing materials are secured well in advance of actual needs. Under the direction of the steward, he should see that the most urgently needed supplies or equipment are made ready to transport first, the next most important second, and so on. When packed, the loads are stacked in piles or bins marked with the camp name for which they are destined. The package boss directs the movement of this material to the landing field according to its priority.

The Flight Crew

The flight crew consists of the pilot and the dropper. The pilot is in command of the ship and he must have the last word regarding all flights. The dispatcher who is in general charge of the flying must, in the end, submit to the pilot's decision as to whether or not a given flight shall be made. Pilots used in this type of work must be licensed commercial pilots, preferably with a minimum of several hundred hours' flying time. It is highly desirable that ships be fully equipped with instruments and radio and that pilots be trained in instrument flying. Unfortunately, not many airplanes available for this work are now so equipped and not many of the pilots are trained in instrument flying. This is a matter that will have to be worked out before the method can reach its greatest effectiveness. Blind or nearly blind flying will have to be done, at least for short distances, under certain conditions. Tentative plans for better instrument equipment and for bringing about training of local pilots in instrument flying have been suggested to state aeronautics authorities in Oregon and to owners of airplanes likely to be used in this work.

Also, plans are being worked out to place identification numbers or symbols on the roofs of all lookout houses in this region. This marking would not only be of material assistance to planes working on fires, but to itinerant aircraft and even occasionally to airliners strayed from the beam course.

Pilots, as pointed out, are the flight commanders and have the last word regarding take-offs and load limits. The dispatcher's authority regarding these matters will be derived from his knowledge of flying conditions and his ability to lay off the ship if he thinks the pilot is not doing his best.

In the early stages of the development, Wernstedt thought it best for the dropper to determine when to dump the packages overboard. However, it is now generally agreed that the pilot can make this determination more accurately because in banking the ship to circle the camp he constantly keeps his eye on the target, in manipulating the controls he keeps in touch with wind variations, and is therefore better able to determine probable drift. The dropper, on the other hand, is quite busy during the circling watching the last package alight, marking its location on his chart, and getting the next package ready. The pilot therefore signals the dropper when to bale out the bundle.

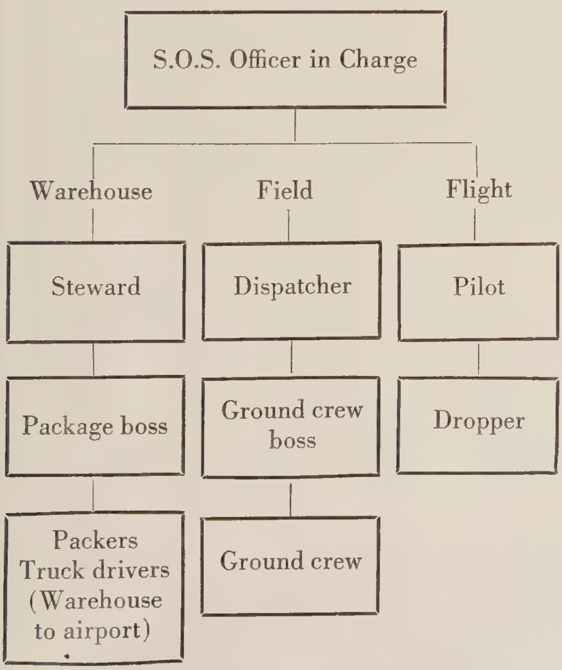
The dropper preferably should be a man thoroughly familiar with the country. This is especially important where planes are to service small camps where the fire may not be putting up much smoke. This requirement, however, is not so important as was first believed, since pilots trained as they are in sizing up the terrain, readily become familiar with the country. Droppers must have had a course of training in the proper and safe methods of baling out packages of different sizes, weights, and shapes. They must thoroughly understand and supervise the proper loading of the cargo in the ship. The im-

portance of this point was emphasized in an incident which occurred on one of the 1938 fires. In this case, a load was loosely stacked in the ship. The dropper was tired and not on the alert. The take-off on that particular trip was exceptionally rough. About the time the ship reached an altitude of fifty feet a light package slipped out the door, the chute opened and spread over one of the tail surfaces. The package fortunately broke away. It was only due to the facts that the ship was manned by a very skilful pilot and that the field was large, that a prompt and safe landing was effected.

The dropper must be able to quickly recognize chutes which are improperly rolled and to tell when a package is too heavy for safe delivery with the number of chutes attached to it. In short, he acts as the final cargo checker.

Droppers should have had sufficient flying time to demonstrate their ability to "take it" under fairly tough flying conditions. Some men become more or less ill at ease or even a bit panicky when the visibility gets very low. Many become air sick when the going gets rough. Some cannot even stand the continual banking which is done while circling the target.

From the foregoing discussion it will be seen that on large projects the following organization or a modification of it is needed:



When good airplane ration lists have been worked out, it will probably be possible for the regular S.O.S. officer to handle the duties of the steward and thus eliminate that job. It is to be expected that with more experience, other modifications and refinements in the organization will be made.

Problems of Visibility

The difficulties brought about by low visibility due to smoke haze have been touched upon. This matter is not important on the east side of the Cascade Mountains. On the west side of the range, however, and particularly along the Coast, it presents a most serious problem. Until some means is found of keeping ships at work even in very smoky weather, airplane transportation cannot be compared in dependability with other methods.

A number of very interesting angles to this visibility problem have already appeared. Apparently, under some haze conditions, ground crews can see the airplane quite clearly when the men in the plane are unable to make out the target or camp area.

A case or two have been reported where the reverse is true. Sometimes when forward visibility is fair (two or three miles) it is almost impossible to see the ground from an altitude of 5,000 feet. Most of the time one can see the ground pretty well from 5,000 or even 8,000 feet when forward visibility is practically nil.

Ships fully equipped with instruments handled by thoroughly seasoned, instrument-trained pilots will no doubt go far toward solving the problem. However, these alone cannot be expected to provide the solution. The regular airways radio beam cannot, of course, be used for the purpose of locating fire camps. A high or ultra-high frequency beam could be developed for the purpose, but the equipment would be expensive and bulky. Since airplane transportation is primarily for use in areas difficult of access on the ground, the disadvantage of such bulky equipment is obvious. It has been suggested that the powerful landing flares might be used to reveal the location of the target. Preliminary inquiry, however, indicates that these flares burn but three minutes and cost around $2.50. If a ship made only six trips in a day with, say, an average of 12 bundles per trip, the cost of the flares would be $178. Besides, while the flares would no doubt serve well as targets, they would have little value in leading the ships into the vicinity of the camp.

Probably a combination of ultra-high frequency ground-to-ship voice radio and a portable

directional electric light beacon will make deliveries possible under much worse visibility conditions than at present. With the radio, the ground crew would be able to give the pilot rough course directions and lead him at least to the vicinity of the camp; then, aided by the sound of the motor, the light gun could be set on the ship as accurately as possible. Without question, numerous defects will appear in this system and will have to be overcome. At any rate the idea seems well worth trying, particularly since the Forest Service already has the necessary radio equipment and the cost of the light gun is moderate.

With the present interest on the part of airplane owners and protective agencies and with forest officers in the Northwest, California, and elsewhere actively working on the various problems, it seems likely that we can look forward to considerable refinement and much wider use of the method in the future.

BUILDING UP A SHORTLEAF-LOBLOLLY FOREST IN ARKANSAS

By WILLIAM L. HALL
Consulting Forester, Hot Springs, Ark.

For some strange reason or other, foresters as a group seem to show no decided inclination to invest in timber producing properties. Undoubtedly there are many reasons for this. Perhaps foresters know too well the hazards of fire, of insects and fungi, and of the heavy tax load to which forest properties are subjected. It is refreshing, therefore, to find a forester willing to invest his savings in a forest property. It is still more refreshing to find that this investment does not seem to have "turned sour." There are few things that would so favorably affect private forestry as a large number of followers of the excellent example set by Mr. Hall.

IN 1928 the writer began acquiring small areas of timberland in Hot Spring County, Ark. It was desired to have a property on which full control could be exercised and on which close personal study could be given problems affecting growth and the building up of the timber stand to a satisfactory level of productivity. It was also desired to test this form of investment for future income. Purchases have proceeded slowly and even now the total area is only about 940 acres.

The area is in a good section for shortleaf and loblolly pine growth; shortleaf pine prevails on the ridges, loblolly pine along the spring branches. Oak, hickory, gum, and dogwood form a considerable part of the stand except on old fields. A good deal of care has been exercised in the selection of the lands, mainly to avoid light stands and unstocked old fields. Altogether about 10 percent of the total acreage is old fields and about two-thirds of this is partially to fully stocked with pine. This leaves some 30 acres of open or slowly restocking old fields.

The site class for shortleaf pine ranges mostly between 60 and 75; for loblolly pine, between 70 and 85.

Fire damage during the 10-year period has been considerable, though no extremely disastrous fires have occurred. During the first five years the acreage burned annually averaged about 7.3 percent of the total. During the second five years it has averaged about 3 percent. In 1934 the lands were placed in the state protection system. Before that systematic protection was not possible. Without question the success of this undertaking depends fundamentally on the degree to which fires can be controlled under the state system. If the annual loss can be held as low as one or two percent, then the outcome of the investment will depend mainly not on fires but upon treatment of the stand.

On most of the area the virgin timber was removed between 1900 and 1910. The cutting was generally close, but in places some of the less desirable trees between 10 and 16 inches in diameter were left standing. Despite fires and other adverse conditions that prevailed the stands renewed themselves and the young trees grew. Intermittent cutting has occurred since 1910, but the stand now ranges from about 1,200 to 3,500 feet of pine above 9 inches d.b.h. per acre.

Treatment

In portions of the area several things have been done that may be of interest to foresters who are concerned with shortleaf-loblolly pine

problems. Although it was evident that a well-directed timber cut was needed over much of the area, it was not possible to proceed with cutting until 1936. Even then it was possible to cut the pine only. The trees to be removed were marked, and the sale was made on the basis of the marked trees. In the marking first consideration was given to stand improvement. Marked for cutting were trees which were considered financially mature and also some trees in crowded stands in need of thinning. Consideration was given to marking enough trees to give the operator a reasonable cut because this would increase the income from stumpage.

Under this plan trees were marked from 10 inches d.b.h. up to largest size, about 24 inches. Everywhere the marking left in the stand the trees of more perfect form, up to about 18 inches. Above that size the form of the tree was generally such that it was not desirable for future growth.

This plan of marking and cutting was applied to about 140 acres. The cutting was closely inspected and was satisfactorily done. When completed it was found that about 1,100 feet per acre had been removed. On one 60-acre tract the income was sufficient to return the original purchase cost and all taxes up to the year of cutting. On an 80-acre tract more than one-half the costs were returned.

After the cutting, the fact was evident that these stands included many defective or ill-formed trees which never could have any considerable value. These trees merely occupied space and prevented other trees from growing. Mainly they were oaks, hickories, and gums. A nearby woodsman accepted the job of killing these trees at $1.25 a day. At a cost of some $50 he worked over about 400 acres, girdling not all but a great number of the undesirable trees. Some died immediately; some died after a few months; but some of the gums still linger on. It has been a joy to see these useless trees pass out of the stand.

There were spots, covering altogether a good many acres, where the stand included only trees too small to make sawlogs. Generally such stands were very dense. Shortly after the log cutting, a pulpwood market opened up and gave opportunity to deal with some of those dense young stands. Again the first step was marking. We selected and marked the best trees in the stand, spacing them as nearly as possible 10 to 15 feet apart. The remaining trees, insofar as they were large enough, were then cut for pulpwood. This treatment seemed to be just what was needed. The crowding was relieved and the remaining stand includes many fine trees 8 to 12 inches in diameter well distributed over the area with much small growth under 5 inches in diameter.

These stands also included a goodly number of large hardwoods of fair merchantable quality. They consisted of white and red oak, red and black gum, and hickory. Last winter it was possible to work the red oak into stave bolts, the hickory into billets, and some of the gum into veneer logs. The return was not good, but it was thought advisable to eliminate the hardwoods and turn the ground over to pine which is a far more profiable crop.

After the cutting had been made and the hardwoods killed as described, the stand was left with open or thin spots here and there. These were not large, hardly ever as much as half an acre. To wait for Nature to restock them might mean waiting five or six years. We decided against that course. Having done considerable planting elsewhere last winter and having plenty of planting stock on hand, we decided to plant the open areas. Actually we went a little beyond that. A portion of the area is in a wet branch bottom which forms a first-class loblolly site. However, the ground has been so covered with valueless black gum, maple, and alder that the pine has not established itself properly. We underplanted this area with loblolly pine and we will thin out the hardwoods when necessary to give the young pine light according to its needs.

In these several ways we have attempted to get this land into good producing condition. As previously stated, about 10 percent of the area is old field, some of which is open or only partially stocked. Seven years ago some planting was done to fill in a portion of the understocked stands. The results were not very satisfactory. Late planting and ensuing hot dry summers resulted in a low survival. Today, however, probably one-fourth of the planted trees survive in the form of lusty saplings 10 to 15 feet in height. Last winter we went back over the area, planted young pines in all the open spots, and, in fact, extended the planting to other areas. This time the planting was done early in January and with favorable weather during Spring and early Summer, the survival at mid-July was excellent.

In old field stands from 10 to 18 years of age, which vary from open to dense, we have tried pruning from time to time and have liked the results. Last winter some experienced axemen were

employed and the work carried on over about 20 acres. We pruned only as high as a man could reach with an axe—about 8 feet. This removed the worst limbs where the stand is not too thin. It would be desirable ultimately to carry the pruning over one full log length, especially for the trees that are to be left for sawlog development.

It is often observed that among the older trees of a stand which carry the heaviest limbs there are trees of smaller diameter which have few branches but which make rapid height growth. These trees are developing a fine form and will be groomed for the permanent stand. The older, limby trees will be cut for pulpwood or rough sawlogs, whether they are pruned or not.

The writer, having this stand improvement work in mind, has been much interested in Occasional Paper No. 70 of the Southern Forest Experiment Station *Profitable Management of Shortleaf and Loblolly Pine for Sustained Yield.* Dealing with the subject in a general way, the authors of course could not get down to detailed steps to be taken on specific properties, especially on small tracts. The writer is not inclined to take exception to the broad statements of the paper as to stand improvement. Yet he is impressed with the view that in beginning the profitable management of any timber property, be it large or small, there is a large number of minutia, down to the point of dealing with particular spots, that must receive attention if the property is to be started on the road to productivity. Many slow and painstaking steps are necessary.

Close observation of the property herein discussed is leading the writer to the opinion that under such conditions intensive forestry is likely to prove more profitable than extensive forestry. It may well be that \$10,000 invested in 1,000 acres of normal forest, fully stocked and with no hitch-hikers, with a high percentage of volume in trees 18 inches and up, will prove a better investment than \$10,000 invested in 2,000 acres of usual forest, half stocked or less, with many valueless trees and nearly all the productive trees under 15 inches. It is the big, tall, clean-bolled trees, distributed all over the tract that are going to bring the real income.

Another Training School in Mexico

ANNOUNCEMENT has been received from the chief of the Department of Forestry, Game and Fish of Mexico that they are establishing a school in the National Forest Reserve, Las Molinos de Perote, Vera Cruz, to train engineers (foresters). The notice states that the area selected is mountainous, covered with beautiful timber, with lakes and is near the tropical coast. The announcement is signed by Engineer Miguel A. de Quevedo, who is known to a number of American foresters, as he has visited the United States several times. For some years Mexico has had a forest guard school at Tlalpam, D. F., Mexico, which is now in charge of Prof. Sergio Barojas.

PREEMBRYONIC SELECTION IN THE PINES

By W. P. STOCKWELL
California Forest and Range Experiment Station

Forest tree breeders have noted with interest the operation of natural selection in the seedbed, especially such examples as the early death of most monstrosities and albinos and the suppression of weaker and the dominance of stronger plants, but they have given little consideration to natural selection during the stages of seed development before the embryo matures. It is upon this preembryonic selection, however, that the character and composition of indigenous pine forests primarily depend.

NATURAL selection can become operative only at periods of choice when one or more alternatives are possible. It is only at such periods that the plant breeder can attempt to influence selection and so direct the course of evolution in his experimental material. As more attention is focused on forest tree breeding in general, more knowledge will be needed concerning the laws of natural selection that are operative within the various genera concerned. In the conifers the process of seed development is different from that in the hardwoods (*2, 3*). Without analyzing in detail the morphological development of the seed in the pines, let us consider those stages during which preembryonic selection occurs and seek the possible causes of the selection, noting particularly vigor as a determining factor.

Pollen is abundant in the air of pine forests during the spring and early summer, when pollination occurs. Pollen from several trees may settle in the axil of a cone scale so that it is possible for any one of these trees to be the male parent of the seed embryo. As each pollen-shedding tree is heterozygous for many characters, the theoretical possibility for variation is infinite. Study of the trees within a given stand discloses marked variation but even more marked similarity. Such uniformity must be attributed to some form of selective elimination operating to suppress many of the possible types. The plant breeder in his effort to influence plant development has devoted most of his energy to pollination, but it is becoming increasingly evident that changes can be effected in plant material at other levels in the scale of development. This is attested by the new forms resulting from treatment of seeds and other plant tissues with chemicals, rays, temperature changes, centrifugal force, and by other means (*1, 5, 6, 8*).

When pollination begins the conelet expands to receive the pollen, which sifts in and partly fills the axils of the loosened cone scales. Through the mycropylar opening of each young ovule adjacent to the axil of the cone scale a drop of liquid is first exuded from and then withdrawn into the pollen chamber (Fig. 1). Many pollen grains adhere to this drop of liquid and so are drawn into the pollen chamber of the ovule. In this paper this chance selection of a portion of the available pollen will be considered the first preembryonic selection in the seed development of the pines. In hybridization the plant breeder carefully controls this selection by making available only pollen from certain trees. In nature, however, selection occurs by chance, and occasionally pollen of grasses and other foreign plant species is found in the pine ovule.

Many of the pollen grains entering the pollen chamber germinate, but only a dozen or two survive and send pollen tubes into the nucellar tissue of the ovule. This is the second preembryonic selection. Weak pollen soon dies, and the growth of pollen from foreign species is inhibited, as in many other plant genera, by some substance or condition in the ovary peculiar to the species or relationship group. The causes of this failure in growth of foreign pollen are obscure, but this inhibition has been demonstrated in Viola by Gershoy (*4*) and in several species by O'Connor (*7*), to cite but two authorities, and has been observed in Pinus by the author.

After germination the pollen tube grows for approximately one year in the nucellus before the two sperm cells that effect fertilization are formed. This period is important in maintaining the character of the species, because it is long enough to permit the suppression of weak pollen and the suppression of pollen that is not perfectly compatible with the species. It is another step in the succession of preembryonic selection.

During the year that the pollen is growing in the nucellus and before fertilization is possible, the embryo sac within the ovule develops through several stages, culminating in the formation of

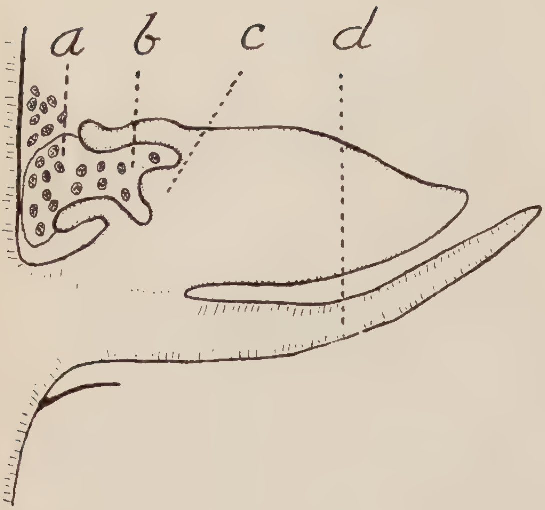


Fig. 1.—Early stage showing manner in which pollen grains reach the pollen chamber of the ovule. *A*, fluid drop with pollen grains; *b*, pollen chamber of the ovule; *c*, nucellus; *d*, cone scale. Adapted from Smith.

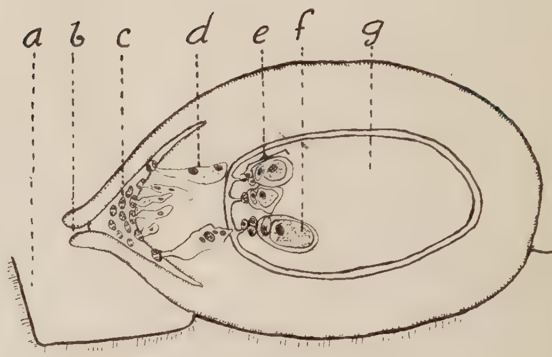


Fig. 2.—Ovule immediately preceding fertilization showing, *a*, axil of cone scale; *b*, micropyle of ovule; *c*, pollen grains in pollen chamber; *d*, pollen tube with sperm nuclei; *e*, archegonium; *f*, mature egg cell in archegonium; *g*, embryo sac. Adapted from Wettstein.

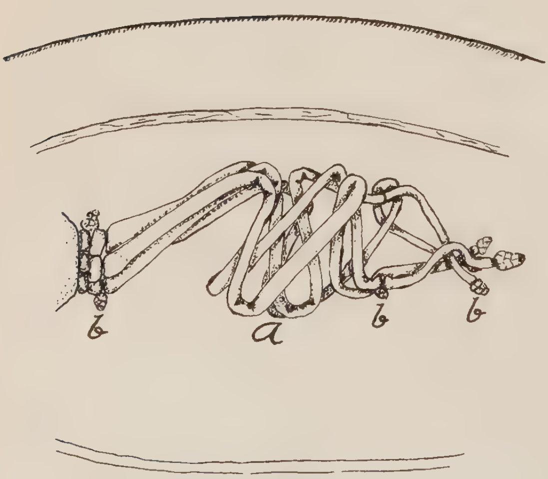


Fig. 3.—Section of ovule showing, *a*, suspensor apparatus; *b*, preembryos. Adapted from Buchholz.

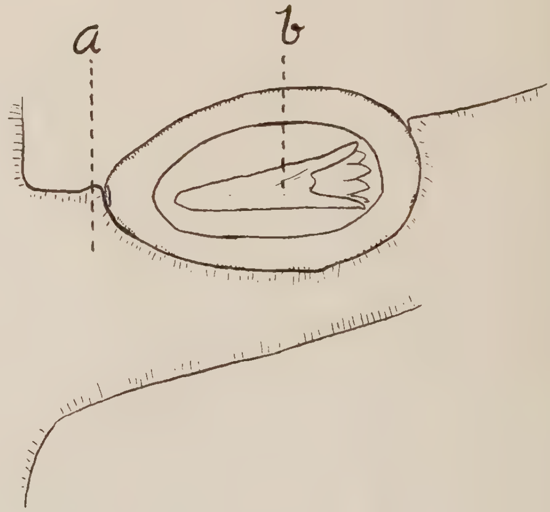


Fig. 4.—Mature seed showing embryo. *A*, cone scale; *b*, embryo.

from six to twelve archegonia, each with a mature egg cell ready for fertilization (Fig. 2). Many of the cells of the embryo sac seem to be potential archegonial initials, but the small number of archegonia developed indicates that certain cells possess some inherent advantage over most of their neighbors. The time at which growth starts, the position of the initial in the female gametophyte, and the size and vigor of the initial influence its ultimate success at this stage of preembryonic selection.

At the time of fertilization half a dozen or more mature archegonia and pollen tubes persist. The pollen tube approaches the neck of the archegonium and the sperm cells make their way to the egg cells, the larger one uniting with the egg to consummate fertilization. Usually only one archegonium is fertilized, although occasionally two or even three fertilized archegonia may be observed. Vigor may determine this fifth preembryonic selection, but it seems probable that the relative positions of the pollen tubes and archegonia are more important.

From the fertilized archegonium develops a suspensor apparatus (Fig. 3), which is composed of four jointed tubes, each having a proembryo at the distal end. Proembryos have been observed to grow from several points on the suspensor apparatus, thus establishing the possibility that a dozen or more may develop, although from four to six are usually seen. In most instances only one of these proembryos matures into the embryo of the normal seed of Pinus, but occasionally twin plants are found in the seedbed, and on one occasion three seedlings from a single seed of *P. ponderosa* were observed at the Institute of Forest Genetics.[1] Several factors, such as position with regard to food supply and competitors, time of fertilization and the subsequent initiation of growth, and inherent vigor, may influence this final selection of a certain proembryo for maturation, the last factor playing an important and perhaps the determining role. This conclusion is reached when different stages of embryo development are observed in which there is a gradual growth of one embryo with concurrent shrinkage and dissolution of the others.

The mature pine embryo (Fig. 4) is then the result of six or more natural selections made during the course of development. Some of these are chance selections; others are competitive and reflect inherent vigor or genetic superiority. By this series of selections species hybrids and inherently weak or partly compatible forms are eliminated and the vigor and the uniformity of pine stands are maintained. From a study now under way at the Institute of Forest Genetics it is hoped to determine whether or not the forest tree breeder can influence selection at these different preembryonic periods and so produce better trees.

[1]The Institute of Forest Genetics of the California Forest and Range Experiment Station at Placerville, Calif.

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THE PLACE OF NAVAL STORES OPERATIONS IN FOREST MANAGEMENT

By S. J. HALL

Forest Managers, Inc.

The naval stores region covers some 44 million acres and supplies labor to several thousand workers. Timberland owners are continually confronted with the problem of whether to turpentine or not. Upon their decision depends to an important degree the success of the South in providing labor for the already hard-pressed workers who are out of jobs because of reduced cotton acreage and roving instincts. Timber growing in the South, including turpentining, must play an increasing part in land use and in providing jobs. Will it do it?

A FEW forest landowners and a few foresters see no place for naval stores operations in forest management. They claim that better returns can be made on a forest investment in the long run by growing large, high quality timber for poles, piling, and sawlogs, and that to turpentine the timber would cause more loss in the final yield that would be justified by the immediate income that would be obtained.

A careful analysis of the facts discloses that this contention may not be defensible. It is true that the old naval stores practice of turpentining small trees did result in an economic loss. In the same way deep chipping, wide faces, and other destructive practices followed by fire resulted in a tremendous waste of timber. Those days are past. It is now widely recognized that no trees smaller than 9 inches d.b.h. should be cupped, and the more progressive forest landowners now favor a 10-inch minimum or even higher. Conservative working is now the rule, and fire protection is practiced by everyone who is making any serious effort to grow timber.

One opponent of turpentining pointed out that a line piling 50 feet long is worth $3\frac{1}{2}$ to 4 cents a lineal foot stumpage, whereas naval stores operations destroy $1\frac{1}{2}$ lineal feet of piling a year per tree at a return of only 3 cents. The answer to this is that to make 60-foot piling a stand must be over 50 years old even on very good sites, whereas naval stores revenue can be obtained when the stand is 20 to 25 years old. Furthermore, in a good 50-year-old stand only one tree out of three, or possibly four, will meet the piling specifications. The other three trees have to be utilized as other less valuable products. Why should we refrain from cupping four good 10-inch trees now on the theory that one of them will be worth $2 in about 25 years, and the other three possibly $1.50 each? We can make nearly as much money in 10 years' shorter time by turpentining all four for two six-year periods at a return of about $1 each. Furthermore, this procedure is the only practical one in this territory where we do not have all-aged stands to start with. An annual revenue sufficient to meet taxes, fire protection costs, and other expenses can usually be obtained in no other way.

Fortunately, there is a way to combine the desirable features of both methods, and that is to select and turpentine the three trees that will not make piling and leave the other round. This method is practiced in France where it is known as "the tree of place method." It was demonstrated to me by the late Dr. Austin Cary, who recommended it highly.

A number of investigations show that turpentining slows down the rate of growth about one-third for one face and 40 to 50 percent for two faces. Trees are seldom killed or windthrown as a result of conservative turpentining. Turpentined butts can be utilized for most purposes. They are taken as pulpwood, lumber, stave bolts, and even in the case of poles and piling, two to three feet of turpentined face is allowed on one side.

After deciding that turpentine operations are advisable, the next question is, how should they be handled? There is considerable difference of opinion about this matter. Some owners prefer to lease the turpentine privileges to a turpentine operator from year to year or for a period of years. Thus they avoid the risk of proprietorship and the many details incident to carrying on the business. They are also relatively sure of a constant annual income. The lease is paid for either in advance for a period of four, five, or six years, or in annual payments. In some cases the lease is on a percentage basis, i.e., the owner receives a fixed percentage monthly of either the net or the gross receipts from the sale of the turpentine and rosin.

The choice of methods depends primarily upon the temperament, business ability, and desire of the owner. If he is willing to take all responsibility on his own shoulders and has the knack of handling labor, he would do well to carry on his own operations. In this way he would have complete control of all operations on his property. If he wanted to cut certain timber before it had been turpentined, or while it was being turpentined, there would be no lease to prevent it. He could use the labor during slack seasons to plant, thin, or carry on cutting operations. Furthermore, he would be apt to have a more efficient fire prevention and fire fighting organization than would a lessee turpentine operator, who would not have so much at stake.

It is also probable that he would be able to get the naval stores work done more conservatively, which would lessen the timber depletion a very considerable amount over a period of years. For example, the height of chipping should be held to one-third inch per streak, whereas the majority of turpentine operators consider that they are doing well to average one-half inch per streak.

Here is an opportunity to reduce naval stores depletion 33 1/3 percent and prolong the working life of each tree 50 percent. It cannot be accomplished by waving a wand, however, as it requires a long period of training to change the habits of a life time. The chippers and pullers must first acquire the skill necessary to make the lighter streak, and this necessitates stable labor conditions so that the men will remain long enough to learn and practice conservative work. At present, the labor supply is so unstable that it is not uncommon to have four or five different chippers in a crop during a year.

A good woodman strives to get each new man to do proper work and after five or six weeks has made encouraging progress. Then one morning the chipper does not show up for work. He has taken a notion to move along to another place and no argument can persuade him to stay. All the woodsman can do is to go out and search the recruiting offices and highways for another chipper. He cannot be choosy, either, as most any kind of streak is better than no streak at all, and naval stores labor is usually so scarce that few operators are able to get done more than 80 to 85 percent of the work they plan. It is for this reason that it would not be practical for the owner to write a turpentine lease requiring that the height of streaks shall not exceed one-third inch.

I do not mean that the owner should be lax about requiring the lessee to conform to good naval stores practice. He should require as conservative work as can reasonably be expected, but he should not expect the impossible. When the lease is on a percentage basis, it should be especially exacting about all matters affecting the quantity and quality of the product produced. The use of rust-free cups and gutters, a minimum number of regular streaks, frequent dipping, and the use of proper cup covers are all reasonable and extremely important requirements.

This is not the place to go into the details of a turpentine lease. Suffice it to say that if the owner intends to lease and has not had sufficient experience himself to draw up a good lease, he should get some competent person to do it. Too many leases are entered into without sufficient forethought. Frequently the owner signs a short form of lease submitted by the turpentine operator and later finds that it amply protects the operator's interests but does not give much consideration to his own; or he will get a lawyer to draw the lease for him, in which case it is apt to be air-tight in every legal respect but deficient in practical matters pertaining to the conservative and proper working of the timber.

Although naval stores operations as now carried on are an important adjunct to successful forest management, there is good reason to believe that they will become much more important in the future. But first there is the problem of how to develop a permanent supply of skilled and satisfied labor. I believe that there have been very few years in the history of the naval stores industry when there was an ample labor supply to make a normal crop of 500,000 units. As a result, naval stores operators resort to expensive and somewhat unbelievable methods of getting and keeping labor. In normal times they advance money to men far beyond their ability to repay. They send out labor recruiters to persuade men at other camps to come to their own, and some make promises that they cannot possibly fulfill. They think nothing of sending a truck 100 or even 200 miles to move a couple of families. If necessary, as is usually the case, they will send $50 to $100 with the truck driver to pay the accounts of the men to be moved.

As a result, the labor has become seriously demoralized. Some of the men make a practice

of staying at a camp for a few weeks, getting all of the advances they can, then leaving during the night for the next easy mark. The operator's loss on hands accounts each year is tremendous, especially at the places which are less accessible and more difficult to get worked. For the same reason, other expenses are unduly high. For example, in order to keep labor it is considered necessary to have large central camps instead of scattered small camps. As a result, the operator has to haul the men to and from work instead of letting them walk as they could if the camps were well distributed over the property. The truck expense on the average operation is always a much larger item than it should be.

The actual labor cost of chipping and dipping is only about $2 to $2.25 a barrel of gum, but the total cost including supervision and overhead is about $5, and this does not include winter expense, depreciation, or depletion. With a permanent supply of labor, the supervision cost could be considerably lowered from the present level of $10 to $12 a crop per month. By renting the crops to responsible workers on a barrel basis, it could be nearly eliminated on some operations.

When the labor problem has been solved, I believe that timber depletion for naval stores operations will eventually be reduced one-third and that operating expenses will be reduced at least 20 percent. These savings are well worth working for and will benefit both the timberland owner and the naval stores workers.

THE OPPORTUNITY FOR FORESTRY PRACTICE IN THE CONTROL OF GYPSY MOTH IN MASSACHUSETTS WOODLANDS

By C. EDWARD BEHRE

Northeastern Forest Experiment Station[1]

With the gypsy moth recognized as an established pest in New England, control effort in Massachusetts woodlands should turn from measures aimed at eradication to the creation of forest conditions less favorable for serious outbreaks. The woodlands of Massachusetts west of the Connecticut River valley are shown to offer a much better opportunity for silvicultural control than those in the eastern part of the state. Increasing the resistance of woodlands to gypsy moth attack should be a major consideration in all forestry programs for Massachusetts. Gypsy moth control is thus as much a job for foresters as it is for entomologists.

RECOGNITION of the gypsy moth as a serious pest in eastern Massachusetts about 50 years ago led to a strenuous effort at eradication. Parasites were introduced from Europe and Japan. Artificial control measures, consisting of creosoting egg clusters, spraying foliage, and trapping larvae in bands of tanglefoot or burlap on tree trunks, were undertaken. A state law was enacted under which the towns could be required to appropriate money annually for gypsy moth control. But the effort—undertaken too late, unfortunately interrupted between 1900 and 1905, and largely restricted to residential sections, parks, roadsides, and orchards—proved entirely inadequate. Defoliation in the area which had been infested longest became a common and recurrent phenomenon. The gypsy moth, although checked by natural agencies, notably a wilt disease and parasites, spread until it had reached the borders of New York State.

In 1923, recognizing that eradication of the insect in New England was impossible, the federal government, cooperating with the State of New York, established a barrier zone from the Canadian border to Long Island Sound. By intensive scouting in this zone and prompt eradication of all infestations discovered, it was hoped that the spread of the gypsy moth outside of New England could be prevented.

This acceptance of the gypsy moth as an established pest in New England should have been accompanied by reconsideration of the now firmly entrenched control program in the generally infested area east of the barrier zone, at least as far as woodlands are concerned. Artificial control measures, aimed at eradication, and effective in the protection of street trees and orchards, are futile when applied to woodlands in the generally infested region. With the man power and equipment available artificial control for these woodland areas is physically impossible; with adequate man power and equipment the cost would

[1]Maintained at New Haven, Conn., in cooperation with Yale University.

be prohibitive. Furthermore, failing to modify causative factors, such measures are only palliative and can be only temporary in benefit. It has been observed repeatedly that areas treated one year may be defoliated again within a few years. On the other hand, defoliated areas are often relatively free from attack in succeeding years without any treatment at all.

Feeding Habits Offer Key to Control

Prior to 1935 little use had been made of the results of early studies by the Bureau of Entomology which showed that the larvae have a marked preference for some species of trees and rarely feed on others. Gray birch, basswood, alder, and all species of poplar and oak are among those highly favored by the larvae; white ash, balsam, dogwood, tulip, and sycamore are among those not favored at all. Intermediate, but usually ignored in the presence of highly favored species, are the maples, the hickories, yellow and black birch, elm, and black cherry. Pine, spruce, hemlock, red cedar, and beech will not support the insect in the early larval stages, but are highly favored by the larger caterpillars.

Early experiments by the Bureau of Entomology in altering forest composition for control of the gypsy moth sought for the most part to replace stands predominantly of oak, a highly favored genus, with pure white pine by planting. To accomplish this transformation requires two or three weedings subsequent to planting and is a costly undertaking. Early results were not convincing because natural factors checked the moth population over most of the infested area before the experimental plots had proved their worth.

In localities where favored and unfavored species occur together, however, the forest can be rendered resistant to gypsy moth attack by gradual reduction of the most favored species through silvicultural treatment. Study of 81 defoliated areas in the town of Petersham in 1935[2] showed that all the outbreaks occurred in stands where favored food species comprised over 50 percent of the stand. In 70 percent of the defoliated stands poplar, gray birch, and oak constituted over 75 percent of the stand. These findings, corroborating a tendency shown by long time records on more than 100 observation points maintained by the Bureau of Entomology in the eastern portion of the infested area, justify the conclusion that serious damage from gypsy moth is not likely to occur in stands where less than half of the foliage volume is of favored food species. Thus it is apparent that ultimate success in control of the gypsy moth is a forestry problem and that foresters should not be content to leave the task entirely to the entomologists. It is the function of foresters rather than entomologists to take the lead in the application of silvicultural practices to render the forest less susceptible to insect attack.

Specific treatments for various forest conditions were suggested in 1936 by Behre, Cline, and Baker.[3] It is significant that the results of exploitation and fire have created conditions more favorable for the gypsy moth than the original forest types. Silvicultural control is, therefore, largely consistent with the natural ecological trend, and fortunately enough, the application of best silvicultural practices to rebuild the depleted forests of the region will to a large extent meet the objectives of gypsy moth control as well.

The natural forest types of new England differ widely in susceptibility to gypsy moth attack. The northern forest, which extends through most of the Berkshire region in Massachusetts, is naturally resistant and rarely has experienced a serious outbreak of the insect. The oak forests of southern New England, on the other hand, are predominantly of species highly favored as food by the gypsy moth, although up to the present epidemic outbreaks in this region also have not been common. Between these two types lies the white pine region, in which highly favored and unfavored food species occur in a great variety of mixtures. This region, which includes most of Massachusetts, has been subject to the most severe gypsy moth attack, and yet offers the best opportunity for silvicultural control.

Opportunity for Silvicultural Control

State forest survey data.—In Massachusetts, forest surveys of almost 100,000 acres of state and town forests widely scattered over all parts of the state, except Cape Cod, offer a crude yet indicative measure of the proportion of the forest lands in various categories with respect to gypsy moth attack. Analysis of the occurrence of favored and unfavored food species in the samples represented by these surveys will show the extent

[2]Baker, W. L., and A. C. Cline. A study of gypsy moth in the town of Petersham, Mass., in 1935. Jour. Forestry 34:759-765. 1936.

[3]Behre, C. E., A. C. Cline, and W. L. Baker. Silvicultural control of the gypsy moth. Mass. Forest and Park Assoc. Bull. 157. 1936.

to which Massachusetts forests lend themselves to silvicultural control measures.

The forest surveys were made by the Mass. Conservation Department under the direction of D.C.A. Galarneau between 1924 and 1933. Quarter-acre sample plots were taken at intervals of about 600 feet, along parallel compass lines run 600 feet apart. Tallies were made by species and diameter classes wherever the stand averaged 4 inches or more in diameter. In younger-aged classes a code description of the stand was given, listing the species in order of their abundance and indicating the average diameter. The field notes also show the presence of coniferous understories and plantations, with the date of establishment indicated for the latter. In addition, the dates of weeding or other cultural operations are shown.

In analyzing these data the stand at each plot point was assigned to one of the five following classifications, according to its resistance to gypsy moth, using the type notes, the stand tally, or both, as a basis:

1. Fully resistant. Less than 10 percent favored food species. Stands of pure conifers, northern hardwoods, and red maple swamps were considered fully resistant. No treatment is necessary for gypsy moth protection in such stands.

2. Dominantly resistant. From 10 to 40 percent favored food species. This group included stands predominantly of northern hardwoods, soft maple, hickory, or softwoods, and recently cutover areas where the surrounding growth was predominantly northern hardwoods. While serious outbreaks of gypsy moth are unlikely to originate in stands of this category, silvicultural treatment can be recommended and a fully satisfactory composition may generally be attained with one treatment.

3. Equally divided. From 40 to 60 percent favored food species. In this group were thrown mixtures of northern hardwoods with oak, gray birch, paper birch, poplar, or aspen; mixtures of softwoods with the same favored food species, and recently cutover areas surrounded primarily by softwood stands. Stands in this group can be modified so that infestation is not likely to originate in them by one silvicultural treatment, but a fully satisfactory composition will generally require two treatments.

4. Dominantly favored. From 60 to 90 percent favored food species. Stands in which oak, gray or paper birch, poplar, or aspen predominate, and recently cutover areas in the midst of oak types, constitute this group. To attain reasonable safety two or more treatments spread over a period of 10 or more years generally will be required. Cultural work may need to be supplemented by planting. In many cases conversion to a more resistant type will be facilitated by taking advantage of the presence of an understory of less favored species such as red maple.

5. All favored. From 90 to 100 percent of favored food species. In the pure stands of oak, gray or paper birch, poplar, aspen, or alder in this group, conversion to a resistant type will only be possible in the next generation of trees through planting or the encouragement of an understory of less favored species.

In the foregoing classification, paper birch was grouped with the highly favored food species. Softwood species were not considered in the favored food class, although when softwoods occur in mixture with highly favored species, the latter must be reduced to a minor percentage of the total to obtain reasonable safety for the softwoods. Pine plantations on cutover oak land were classified as "equally divided" if no weedings had been made, and "dominantly resistant" after weeding.

Distribution of samples.—Forest conditions in the northern hardwood forest region, of which the Berkshire hills are a part, differ markedly with respect to susceptibility to gypsy moth attack from those of the pine and oak regions which occupy the rest of the state. Hence the figures for the area west of the Connecticut River valley were analyzed separately. Inasmuch as there is a much larger area of state forests in the northern hardwood region west of the Connecticut River than in the eastern portion of the state, a more adequate sample of plots was available for that region. Two-thirds of the total number of plots analyzed were in the northern hardwood region, which comprises only about one-fourth of the area of the state. The representation of samples in the oak-pine region is exceedingly weak, but the similarity of results among the individual widely scattered forests included lends confidence to the adequacy of the average. The distribution and composition of the 11,803 plots analyzed is shown graphically in Map 1.

Results.—In order to interpret the results it is necessary to assume that the entire forest area in each part of the state will be distributed among the five resistance groups in the same proportion as the plots in the arbitrary forest survey samples.

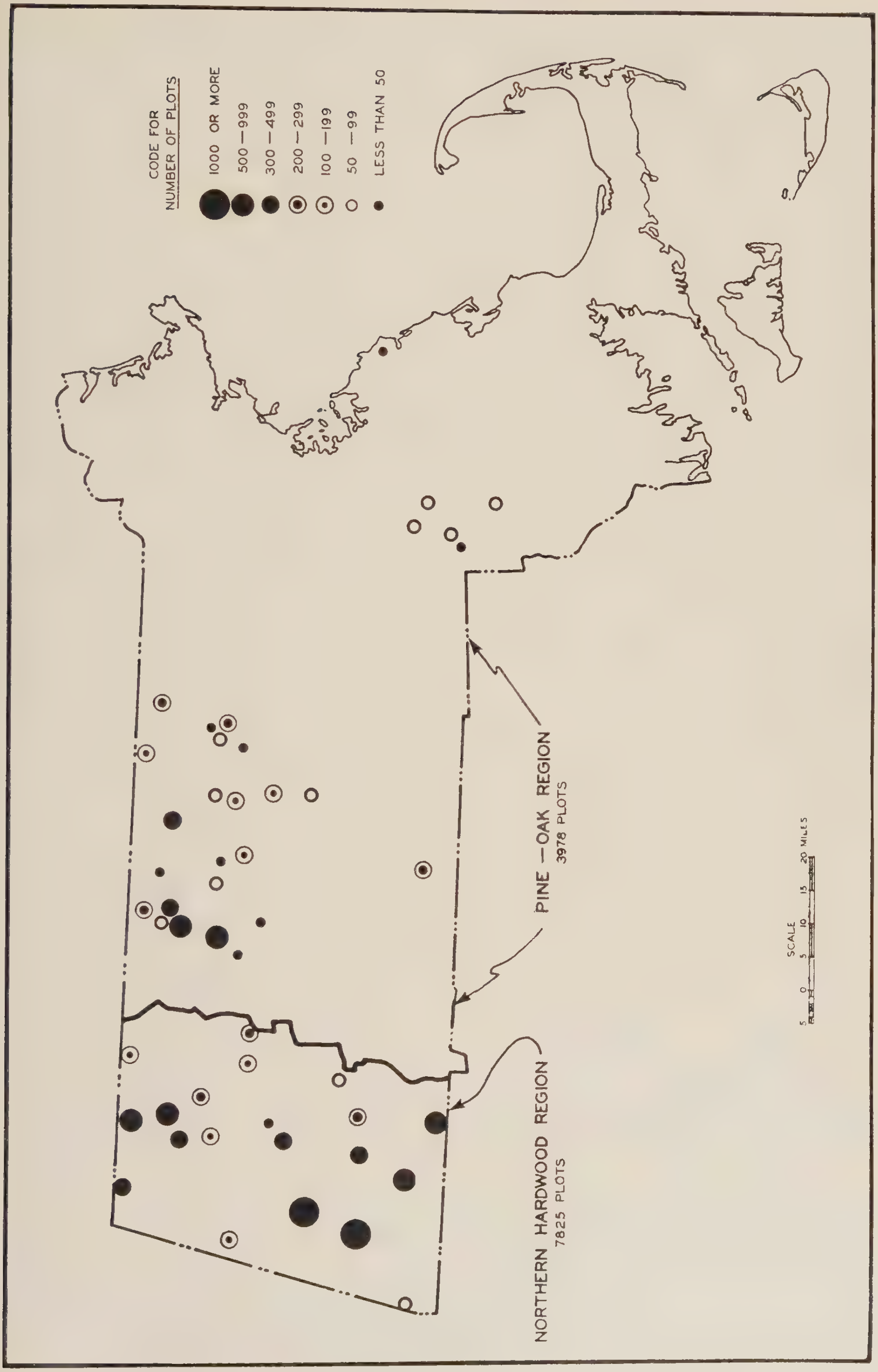

Fig. 1.—Distribution of forest survey data used for analysis of opportunity for forestry practice in control of gypsy moth in Massachusetts.

Although the distribution of samples is obviously inadequate to give much weight to this assumption for the pine and oak region, nevertheless, it is believed that the over-all picture for the area outside of the metropolitan districts and Cape Cod is essentially sound.

The relatively favorable situation in the northern hardwood region in the western part of Massachusetts is shown by the fact that 75 percent of the plots there were classified as either fully or dominantly resistant (Fig. 2). More than 43 percent of the woodland in this part of the state appears to need no treatment for gypsy moth protection. The composition of the stand on another 32 percent of the area can probably be made entirely satisfactory from the standpoint of resistance to gypsy moth in a single silvicultural treatment. Almost 8 percent more, with favored and unfavored species about equally divided, should respond well to silvicultural control measures. On only 17 percent is the problem of creating conditions unfavorable to gypsy moth acute.

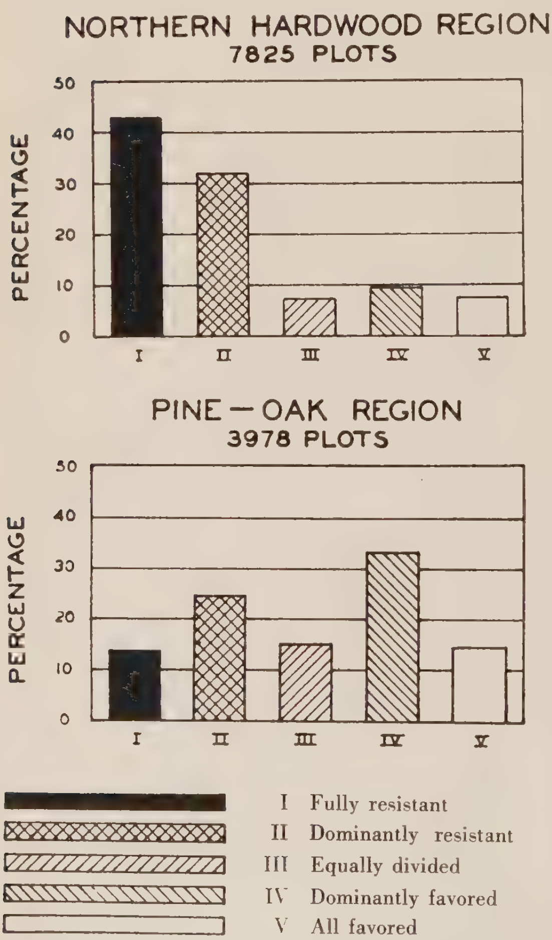

Fig. 2.—Composition of Massachusetts forests with respect to susceptibility to gypsy moth attack.

The pine-oak region presents a much more difficult problem, since about half of the forested area appears to be entirely or dominantly occupied by highly favored food species. However, more than one-third of the woodland in this region was classified in the two most resistant categories; and on another 15 percent, in the equally divided class, danger of an outbreak can be materially reduced by a single treatment. Another one-third, classed as dominantly favored, will lend itself to gradual conversion to a more resistant composition; and only about one-sixth appears to need such drastic measures as clear-cutting and planting on a large scale to eliminate the food conditions most favorable to the gypsy moth.

Recommendations for Action

With the opportunity for obtaining a large measure of permanent protection from gypsy moth through forestry practice as favorable as this analysis indicates, silvicultural control should become a recognized objective in all forestry programs in the state.

The state itself should lead the way by systematic treatment of all public lands to reduce the proportion of favored food foliage in the woods. Plans for improvement of town forests should likewise be directed along this line. Judicious cutting of favored food species along the roadsides may go far to maintain aesthetic values by minimizing the likelihood of defoliation. Extension foresters should encourage farmers and other landowners to give their woodlands the cultural treatment needed to develop a more resistant composition. Whenever thinnings or selective cuttings are undertaken, owners should bear in mind the opportunity to improve the composition with respect to gypsy moth attack. Progress in protection may thus be made without additional cost. Indeed partial cutting may well be advocated in place of the all too prevalent clear-cutting because of its potential benefits in gypsy moth protection as well as for its other advantages.

Since the present system of scouting and creosoting egg clusters by town moth crews in the generally infected area is ineffective and dissipates money without respect to need or benefit,

it seems highly desirable to reorganize the entire local control effort, strengthening the central state organization, employing foresters, and providing means for devoting to silvicultural control a large part of the money to be expended outside of the thickly settled sections.

Crews from the Civilian Conservation Corps assigned to gypsy moth control projects should in most cases place major emphasis on silvicultural control measures. Such work should be extended to private lands just as freely as any other means of combating insect pests, notwithstanding the possibility that some private benefit may accrue to the landowners concerned from the cultural work done.

Even in the barrier zone, where the objective of eradication necessitates artificial control, modifying forest composition to minimize susceptibility to attack should be an important consideration. The control organization has made progress in wider application of selective cutting to eliminate favored food species and in minimizing indiscriminate "clean-up" and cutting of underbrush (which is often of resistant species) to facilitate the artificial control. There should be systematic effort to improve the composition of the forest in all areas where infestations are treated in the barrier zone. "Sore spots," where favored food species predominate, should be located and, if possible, given silvicultural treatment in advance of infestation. Advantage should be taken of seasons and weather unsuited for artificial control to keep available crews occupied with silvicultural work. With so small a portion of the area occupied by favored food species it should be possible by such systematic efforts to make the Massachusetts portion of the barrier zone exceedingly resistant in a relatively short period of years, and thus minimize the intensity of work necessary to maintain that portion of the zone.

In actual procedure priorities of areas for treatment in public programs will depend on the degree of infestation present or prospective, rather than on probable loss in relation to values as suggested for general application by Behre, Cline, and Baker.[4] Preliminary maps should be made as rapidly as possible to show the location of critical areas. Comprehensive maps on a large scale compiled from aerial photographs and showing forest types and site classification will prove helpful. For each area selected for control operations, whether in the barrier zone or elsewhere, a plan of work should be carefully prepared by a technical forester. This plan should include a detailed type map and outline the specific treatment to be given each stand.

Silvicultural control is definitely a job for technically trained foresters and satisfactory results can hardly be expected if the marking of trees to be cut is left to untrained men, even though they may have had long experience in artificial control work. Technical skill of a high order is required to preserve or develop desirable forest stand characteristics. The form, size, vigor, and position of each tree as well as its species, must be considered in deciding on what to remove. Restraint is necessary to avoid attempting to accomplish too much in one treatment. The most difficult technical problems must be faced in working in stands where favored food species predominate, because in these stands conversion cannot be accomplished in the first operation.

The forests of the generally infested area of Massachusetts, which have suffered through over 200 years of indiscriminate cutting, were further depleted by the hurricane of 1938. A long period of careful husbandry will be needed to restore these forests to the place they should occupy in the economic life of the state. If the objectives of developing resistance to gypsy moth is incorporated into all long range plans for forest restoration, the state may look forward to a time when damages from gypsy moth will no longer be a matter of major concern to the owners of woodlands.

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[4] *loc. cit.*

A FIRE DANGER METER FOR THE ROCKY MOUNTAIN REGION

By A. A. BROWN and WILFRED S. DAVIS[1]
U. S. Forest Service

The development of correlation devices designed to measure variations in the potential fire job or fire danger is now receiving attention by all national forest regions. H. T. Gisborne developed the first device of this kind, which he called the fire danger meter, for the Northern Rocky Mountain Region. Many variations of the same principle are now being tried as a recognized part of the service-wide fire replanning project. This article describes the development and adaptation of such a device for the Central Rocky Mountain Region. It represents a pooling of the results of work by many individuals and appears to represent progress toward a common basis for such devices.

An old and very practical problem always confronts the forest administrator and the financial manager responsible for the control of forest fires, particularly if the job is to be done efficiently and economically. This is the problem of correctly appraising from day to day what the probabilities are of fires starting and of their spreading to uncontrollable proportions.

The potential size of the fire job, or the "fire danger" which is the subject of such an appraisal, depends chiefly on three factors: (1) the amount and character of forest fuels; (2) the prevalence or activity of fire-causing agents; and (3) the state of burning conditions. Of these three, the amount and character of forest fuels is the most tangible and its influence on fire danger most easily tested by experience. Methods of testing and rating forest fuels have been developed, and there appears to be fair assurance that if principles of rating set up by the late L. G. Hornby are followed, the ability to properly evaluate the relative danger represented by different fuel combinations will be limited only by the degree of accuracy and detail attained in such work. The second factor, the prevalence or activity of fire-causing agents, or in other terms, the degree of risk of fires starting, is much more elusive. At best it can be determined only on a probability basis, much as insurance ratings are determined. But in this way, it also becomes a definable thing. Of the three, burning conditions have been most elusive of all to measure. This is due in part to the fact that burning conditions represent the net effect of a variety of physical factors on the inflammability of fuels and on the spread of fire in them. Most of these factors are thought of collectively as "weather." The result of sun, wind, and rain, in terms of relative humidity, fuel moisture content, and fire behavior are familiar subjects of research and will, no doubt, in time provide a scientific basis of fire control.

Meanwhile, enough is known to improve the individual's appraisal of the inflammability of fuels or of forest burning conditions generally. As a means to this end, Gisborne in 1933 developed a device, which has been termed the "fire danger meter," for automatic correlation of both burning conditions and risk. Its value for administrative use became quickly apparent and its principle is being widely adapted in varying forms as a guide in regulating the strength of the fire control organization to meet varying fire conditions.

The need for such a device in the Central Rocky Mountain Region is obvious. Regional characteristics include all combinations of fuels, rugged topography, low frequency of dry lightning risk, intense though usually localized man-caused risks, and frequent summer rains. The net result in normal years has been few fires, which have been easily controlled, and as a result the "small fire" organization is typical of the region. The success of such an organization is altogether dependent on a lack of surprises and a fairly fixed combination of fuel and weather conditions favorable to the control of each fire as it occurs. When such dependence fails and fires occur under critical burning conditions, they demand heroic and often unfamiliar action on the part of the skeleton field force. Although critical burning conditions have occurred far more frequently than was commonly supposed, they have usually been of short duration and whenever by chance no fire occurred or was burning at the time, they have passed without incident and at times unnoticed.

Under these conditions the ranger in charge of a district is confronted with the choice of two attitudes toward his fire control problem. If, in the absence of fires occurring in his district, the ranger attempts to keep his organization of

[1]Mr. Davis carried through the analysis of fire statistics described, the comparison of fire danger meter ratings, and developed the design of the meter as adopted.

ranchers and part-time help keyed up throughout the fire season, he places himself in the position of one who is constantly crying "wolf." On the other hand, if he adopts the complacent attitude of "It can't happen here," he loses altogether the interest and support of his fire organization. Both extremes in attitude occur throughout the region. A more rational and uniform basis for local policies and a more definite measure of the threat of a bad fire are urgently needed. If the fire danger can be measured correctly, much of the effort in fire preparedness can be allocated to the right time and place, the fire organization can be more effectively built up, and surprises can be reduced to a minimum. These were the immediate objectives of the work.

The first step in the procedure was a careful comparison and analysis of each of the rating devices or "danger meters" in use in 1937, including the Region 1, Region 6, Region 9, and Appalachian danger meters. The comparison was accomplished through reconstructing from Weather Bureau records and local data the conditions existing before and at the time of each of 312 reliably-reported Class C fires which have occurred throughout the Region since 1920, then of trying out in turn the verdict of each of these meters as to the degree of fire danger that existed. The result was often a surprising range of pronouncements. When these variations were examined, most of the contradictions were traceable directly to the arbitrary weights given to changes in fire risk and to changes in atmospheric visibility. Some ratings went so far as to deny any appreciable fire danger, so long as visibility was good and risk low, even though extreme burning conditions existed.

The 312 Class C fires used represented nearly all the major disasters in the record, and it seemed reasonable that a regional rating device should reflect as accurately as possible the "build up" of conditions under which such disasters occurred. Where human risk predominates, as in this region, no existing means of measuring it appears to have a direct relationship to acreage burned. Rather, such risk seems to be always sufficiently prevalent to produce large fires if bad burning conditions persist. In the same way, atmospheric visibility, which in any case has no relation to burning conditions, only confuses the issue in a territory where few lookouts are used. The central question then appeared to be, "What were the burning conditions?' This led to the decision to limit the rating scheme to burning conditions alone, leaving varying risks and other factors to be incorporated into the interpretation of "what to do about it" locally.

With the decision to limit the ratings to burning conditions, a second decision became necessary. Ratings previously used depended on the adoption of an arbitrary number of classes of fire danger which were supposed to correspond to recognizable successive stages in building up the maximum fire organization. Apparently, such classes represented more nearly an equal division of the range of fire danger than the logical steps in organization. As a result, classes in the lower brackets had little organization significance while those representing emergency conditions were too broad. This is illustrated by the Region 1 meter, in which a change from Class 1 to Class 2 has no real organization significance; while a change from Class 5 to Class 6 has so much that the administrator is concerned as to whether it is high, low, or perhaps after all the middle of the Class 5 condition. The decision was made to meet this difficulty in part by dividing the range of conditions unequally with increasingly narrower classes as emergency fire conditions were approached. By doing so, generalizations of more organization significance to the region could be drawn. This resulted in five classes, the first two corresponding roughly to the first four of the Region 1 meter.

At best, such divisions are purely arbitrary and certain to become an inadequate means of showing rate of change, or of defining characteristic seasonal trends. Accordingly, the divisions set up are regarded only as a basis for broad generalizations in organization requirements subject to future change. Without further means of defining their boundaries, every change would of course disrupt the whole scheme. Accordingly, the whole range of conditions was placed on a graduated scale of 1 to 100, and any point in it could then be expressed on a numerical basis. This permits the description of any class in relation to the whole and any number of classes can be adopted without disrupting the scheme of rating.

If a "danger meter" must be designed to measure total fire danger, which has not yet been attempted in any of the devices, both 0 and 100 percent would be difficult to fix. It is almost equally difficult if both risk and atmospheric visibility are included in the rating; but simplified to only the factors that influence burning conditions, the limits can be set with more con-

fidence. This became apparent in checking burning conditions during the 1937 season and for the periods of each of the fires used from previous years. The worst burning conditions of record in the region, accurately recorded on a Weather Bureau station at Sundance, Wyoming, which was the point of origin of the fire, showed a relative humidity below 5 percent, temperatures at 92° F., a twenty-five mile wind, dry vegetation from prolonged drought, and probable fuel moisture in grass and forest litter well below 5 percent. The result was an 8,000-acre spread in a few hours. This condition represents 97 percent on the scale of 100, since higher temperatures and more wind can and do occur within forest boundaries.

These two features, the restriction of the ratings to burning conditions, and the use of a percentage scale to express them, represent the chief deviations from existing rating devices.

The ratings were developed through a "cut and try" method, guided by the results of the comparisons between the various danger meters. These comparisons gave an excellent basis for assessing the value of distinctive features of each meter and the rating system finally adopted represents in many ways a composite of those features which appeared to best fit Region 2 conditions. The color chart idea in particular, which is distinctive of the Region 6 meter, was adopted for its graphic and public interest value.

At first, only three factors, wind velocity, relative humidity, and time elapsed since the last rain, were tried out as the basis for rating burning conditions at the time each of the 312 fires occurred. For the more recent records, moisture content of a fuel stick was tried as a substitute for the rainfall factor. Using these factors alone, no arbitrary scheme of weighting or combining them appeared to give consistent results for all fires, and it became necessary to introduce further factors and to make progressive adjustments in their weights until no apparent inconsistencies remained.

When this had been accomplished, the records of twenty-six fire danger stations maintained throughout the region during 1937 and records loaned from similar stations[2] for the same period were used as the final check. Records in each case were plotted in graphic form and compared. This permitted an examination of the fire season just completed in terms of the proposed ratings and helped to eliminate further inconsistencies.

The factors finally used and the weights assigned to each in the percentage scale of the meter are as follows:

Wind velocity *M.p.h.*	Value *Percent*
0 to 2	5
3 to 6	15
7 to 12	25
13 to 24	30
25 and over	35

Temperature *°F*	Value *Percent*
60 to 67	0
68 to 75	3
76 to 83	6
84 to 91	9
100 and over	15

For every 8° interval below 60° F. subtract 5 percent unless the 0 percent point is reached.

Fuel moisture + ¼ relative humidity *Percent*	Value *Percent*
40 to 75	5
25 to 39	10
15 to 24	15
8 to 14	20
0 to 7	25

HERBACEOUS STAGE

When annuals are green, subtract 10 percent; when curing, subtract 5 percent; when dry enough to ignite from a match, no deduction.

Precipitation interval *Days*	Value *Percent*
Raining	0
1	5
2	10
3 to 5	15
6 to 8	20
More than 8	25

Class of fire danger day	Value *Percent*
1. Dormant	0 to 30
2. Low	31 to 55
3. Moderate	56 to 75
4. High	76 to 90
5. Extreme	91 to 100

In order to obtain the class of day as defined above, the factors are measured and their percentages totaled. For the present this will be done directly, without interpolation.

The relative influence credited to each of these factors represents both the experience record of the region and the results obtained in research studies by various workers, only a few of which are quoted here. A brief discussion of each factor will serve to clarify its basis.

Wind velocity is given greater weight in the meter than any other single factor. Its profound

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[2]Courtesy of L. F. Cook, associate chief forester, F. W. Childs, regional forester, Omaha; and superintendents of Yellowstone, Grand Teton, Wind Cave, Mesa Verde, and Rocky Mountain National Parks, National Park Service.

influence on fire behavior is universally recognized, though it is given relatively little emphasis in existing rating schemes. The fire and weather records revealed that wind had been the universal contributing factor in every uncontrollable fire that had occurred in the region. Experimental evidence now indicates[3] that the effect of wind on rate of spread of fire on level ground is likely to be a proportional relationship rather than a logarithmic relationship as supposed.

Nonproportional weights, however, were indicated by the record and were assigned as shown above. These take into account roughly the net additional effect of wind in causing spotting and crowning, and in increasing the effect of slopes in speeding fire spread. Strong winds are characteristic of many parts of the region and account for most of the freak fires which at times occur under otherwise unfavorable burning conditions. The evidence indicated a considerable jump in uncontrollability from calm to light wind, but not a proportional jump from the effect of a fifteen-mile wind to that of a twenty-five mile wind.

The effect on current ratings of the strong influence credited to wind introduces rapid fluctuations in the indicated fire danger. Experience last summer, particularly on the disastrous Blackwater fire which occurred on the Shoshone National Forest in August 1937, appears to justify these fluctuations chargeable directly to changes in wind velocity. However, separate attention will be given throughout the region in local plans of action to the prevailing level of burning conditions without wind, since weather forecasting is not yet adequate closely to predict local wind velocity, which often builds up with little warning.

Air temperature influence is theoretically fully accounted for by relative humidity and fuel moisture measurements, since it is important only as it affects rate and degree of evaporation of fuel moisture. It was found, however, in the work of developing consistent burning condition ratings for the 312 fires used, that variations in relative humidity alone did not satisfactorily ex-

[3]Curry, J. R. and W. L. Fous. Rate of spread of surface fires in the ponderosa pine type of California. Jour. Agric. Research 57:239. 1938.

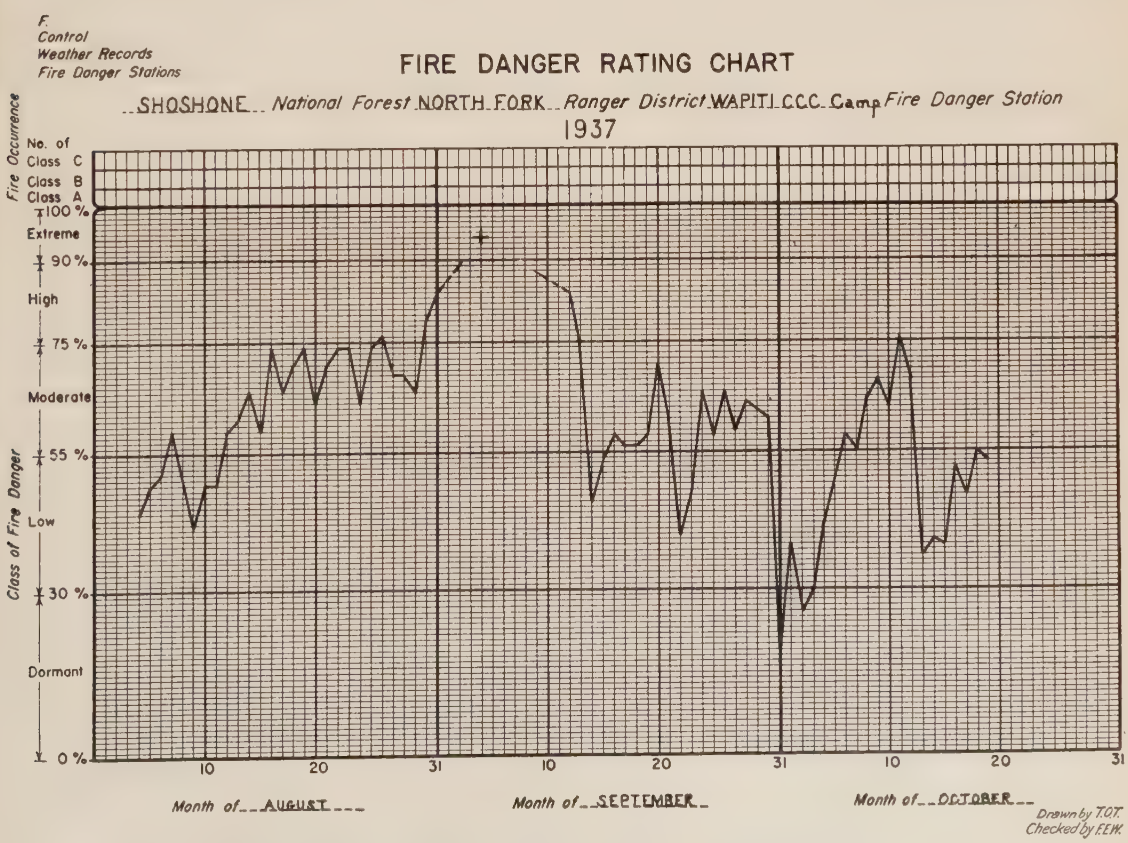

Fig. 1.—A fire danger meter for the Rocky Mountain Region.

plain the variations in burning conditions. Accordingly, air temperatures were also taken into account independently. When this was done, much more consistent ratings were obtained, using the graduated scale indicated above with a maximum of an added 15 percent credited to temperature influence alone. The assigning of additional weight to temperature influence is not inconsistent when it is considered that at a relative humidity of 20 percent and a temperature of 68° F. air has only half the evaporating capacity it does at the same relative humidity at a temperature of 80° F. This added recognition of air temperature influence tends to give more emphasis to evaporation rates than a scheme which takes account of temperature through relative humidity only. The dominant influence of air temperature and the principles involved have been recognized in the publications quoted below.

Relative humidity and fuel moisture stick measurements resulting from both national forest and national park stations maintained last summer followed the same trend so closely that they have been combined for the purpose of the Region 2 meter. The fuel moisture stick measurements show less violent fluctuation but surprisingly little lag. The typical ratio in magnitude between the fuel moisture stick reading and the relative humidity is that of approximately 1 to 4. Accordingly, they are given approximately equal weight by adding one-fourth the relative humidity reading to the percentage of moisture in the fuel moisture stick at any given observation. The composite reading apparently follows the moisture content trends of the important lighter fuels very closely.

Summer rainfall is the greatest single factor in keeping burning conditions at a low point during what would otherwise be the critical fire season in much of the mountain territory. Accordingly, it appeared to be far more simple and direct to use the time that has elapsed since the last rain than to measure cumulative influences through duff moisture measurements or by means of the heavy type of fuel sticks. The principle has apparently been successfully used and tested by both Mr. Stickel and Mr. Mitchell and is incorporated in eastern fire danger meters.[4] It was found necessary, however, to assign less weight than is given in the Region 9 meter, in order to obtain consistent ratings. It was found, too, that rainfall of less than 0.1 inch apparently had little or no effect on burning conditions, due to the rapid evaporation that commonly occurs in this territory. The intervals used are based on the Weather Bureau records preceding the Class C fires used in the study.

Along with summer rainfall, grass and annual vegetation play a very large part in the inflammability of forest cover throughout the region. As a result, particularly in territory where grassy parks are prevalent, the danger of extensive conflagrations depends on the ability of grass and annuals to carry fire. This is borne out by the fact that periods of drought which have lasted long enough to dry up the grass and annuals prematurely have always resulted in destructive fires, and by the tendency for early spring and late fall fires to assume large proportions. Even in slash areas and in closed stands of timber a great deal of lush vegetation follows summer rains and reduces inflammability accordingly. This factor is provided for by subtracting 10 percent from the total reading whenever the grass and annual vegetative cover is up and growing; by subtracting 5 percent when it is curing; and by making no deduction when it is dry enough to ignite and carry fire. An intermediate stage in the spring equivalent to the curing stage in late summer, when new vegetation has started but it not yet sufficient to provide an effective barrier to the initial spread of surface fires, is also recognized and will be further defined. Vegetative stage will be determined by general observations and sample plots in the course of range inspection rather than strictly at the site of the fire danger station.

The fire danger meter as made up is illustrated in Figure 1. It consists of a 16 by 22 inch board equipped with a calendar dial and an easily manipulated system of slides and pointers. The herbaceous stage is taken care of by description. Each of the other four factors is represented by a band running across the board and divided into color brackets, each representing a range of values to which a percentage value for the scale is assigned. Below each band a pointer runs in a slot which can be set at the current reading. The different percentage values are then totalled and a pointer running in a vertical slot at the top of

[4]Gisborne, H. T. Measuring forest fire danger in northern Idaho. U. S. Dept. Agric. Misc. Pub. 29.

Gray, L. G. Air temperature in relation to fire cost and damage. Jour. Forestry 34: 779-785. 1936.

Stickel, P. Measurement and interpretation of forest fire weather in the western Adirondacks. N. Y. State Col. Forestry Tech. Pub. 34.

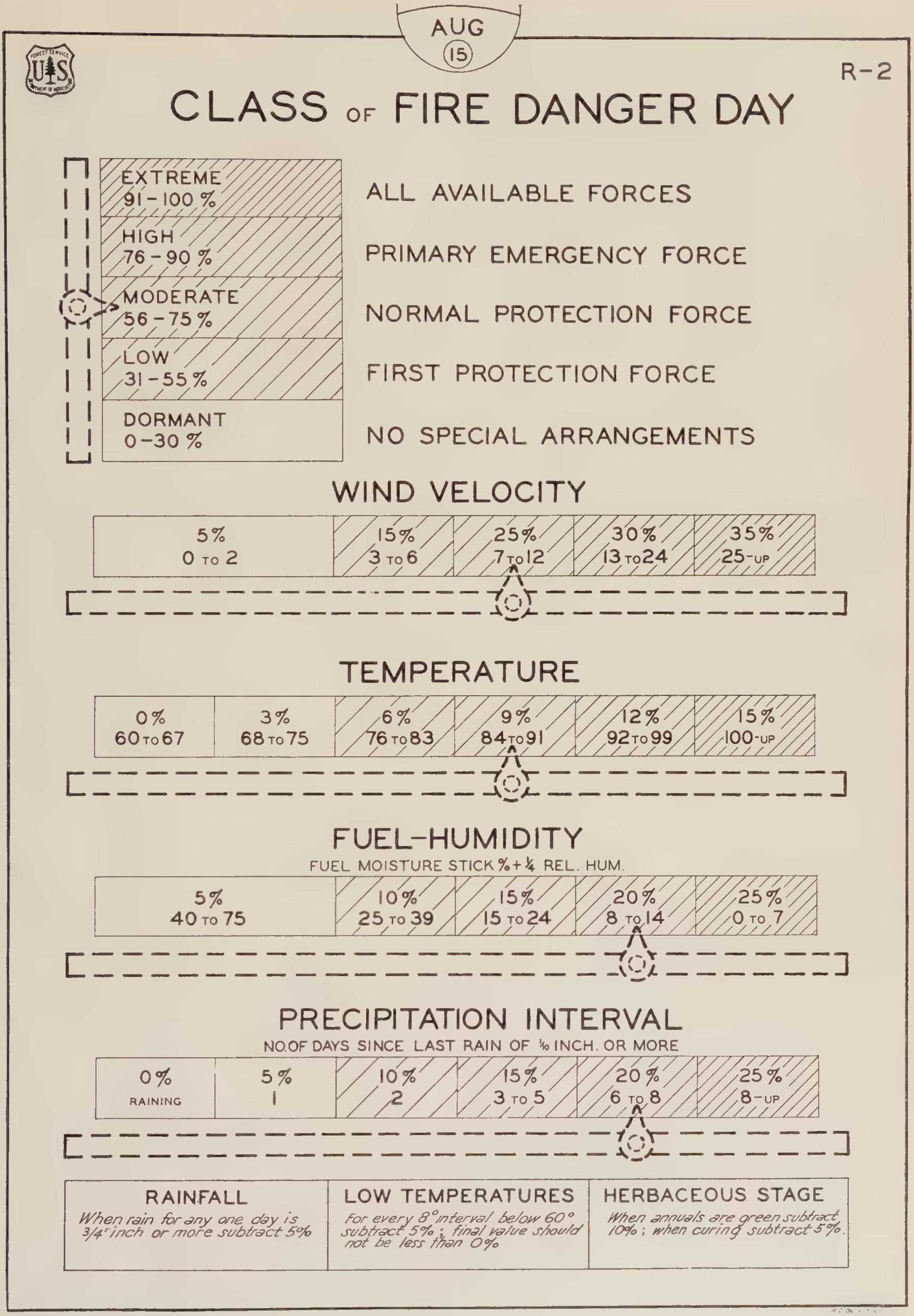

Fig. 2.—Observations taken at the Wapiti C.C.C. Camp on the Shoshone National Forest showing the build-up of fire danger conditions that accompanied a disastrous fire.

the board is set for the class of day represented by this total. A blanket description of the general action to be taken is given opposite each class of fire danger day.

In use, the meter is accompanied by a graph consisting of letter-size sheets which can be mounted together to accommodate the whole period representing the fire season. On these graphs the percent of fire danger by days will be kept. The high point for each day, which is usually the 3:00 p.m. reading, will be used for plotting purposes. The graph which resulted from observations taken at the Wapiti C.C.C. Camp, a few miles from the Blackwater fire on the Shoshone National Forest in August 1937, is reproduced (Fig. 2) to show the build-up of fire danger conditions that accompanied this disastrous fire. The dates of August 20 and 21 represent a short period in which extreme burning conditions occurred. This same high point in burning conditions, although usually lower in the scale, occurred simultaneously on the Black Hills and Harney National Forests, and at points along the front range of the Rockies and in southern Colorado, but did not appear on the Medicine Bow National Forest or at points west of the Continental Divide, both of which localities received a rain at that time.

Since the meter does not go as far in substituting for local judgment as has been attempted by previous rating schemes, it is of course necessary to supplement it in each case with local plans of action based upon local fuels, local risks, and available facilities and man power. These have been termed "step-up plans," and are now in effect throughout the region. They appear to be the means of making the fire danger meter equally useful under the great variety of fuel and climatic conditions represented by the various forests throughout the region.

Approximately 100 of these meters have been put into operation for the 1938 fire season in national forests and national parks. The need of further corrections or adjustments in the rating scheme and in the organization plans which depend upon it will no doubt be demonstrated by experience. However, it is believed that with a sound basis of regional experience as the starting point, no absurdities or wide discrepancies in rating fire danger are apt to appear under the conditions to be encountered in the Rocky Mountain Region.

Wood Waste Used for Plastics

At the Forest Products Laboratory, Madison, Wis., scientists have developed and patented for public service a process for converting sawdust and other wood waste into a marketable plastic.

Mill waste gets its plastic qualities from lignin, the organic substance that cements and reinforces the cellulose fibers of all trees and plants. Pure lignin forms a brittle plastic that needs a fibrous material to strengthen it. The wood itself furnishes this fiber in the form of cellulose. The hardwoods with which the laboratory has experimented—maple, oak, and hickory—contain 20 to 30 percent of lignin. Some work with softwoods indicates their suitability as well.

Under the newest process wood waste is mixed with its weight of water and 20 percent of its weight of aniline, placed in a metal container and held at a steam pressure of 160 pounds for 3 hours. When washed of excess aniline and soluble matter the product is ready for molding with the use of water only. Up to this stage the molding powder should be produced for 3 to 4 cents a pound.

The finished product has the appearance of hard rubber, and can be turned on a lathe, sawed, or bored. It has possibilities for various small articles such as ash trays and buttons as well as larger objects such as radio panels, table tops, and floor and wall tile.

GENETICS IN FORESTRY

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In spite of the inherent difficulties involved in the study of forest genetics considerable progress has been made and today foresters are beginning to be "genetics conscious." European foresters especially, have learned that within each botanical species there may be a tremendous range of inherited differences, not only with respect to physical characteristics such as form, but also physiological characters manifest in growth rate, disease resistance, hardiness, drought resistance, and adaptation to different soils. American forestry should be able to profit by the increased knowledge of genetics and by European experience. Yet a perusal of the literature and contacts with other foresters leaves the distinct impression that considerable confusion still exists regarding the application of genetics to forestry practice in America.

IT HAS been said that forestry is the meeting ground of the sciences. Certainly it is true that foresters who are concerned with either natural or artificial regeneration of forests need a working knowledge of genetical principles. The rather common belief that actual research on trees must be accomplished before forest genetics can be practiced is an unfortunate one and has led to much delay and wasted effort. Trees are organisms; they follow the same fundamental laws of nature as other organisms. Basically, respiration, digestion, reproduction. and heredity are the same throughout the plant and, for that matter, the animal kingdom. There is no known reason why the laws of heredity discovered by experimenting with peas or fruit flies should not apply to forest trees (recall that locust belongs to the same botanical family as peas). In view of the length of time required to carry on breeding experiments on trees, it seems that foresters would grasp with alacrity the opportunity to use knowledge gained in the general field of genetics. Perhaps the failure to do so can be explained by the omission of genetics from the curriculum of most forest schools. Moreover, it is very difficult to become enthusiastic about future generations of forests. There are immediate and pressing problems of a tangible nature, the solutions of which are much more satisfying. Yet a few years from now we may regret our lack of foresight.

Climate and Local Strains

The existence of strains or races within species of trees has been recognized in Europe for many years. MacLarty (*20*), Büsgen and Münch (*13*), Fankhauser (*16*), Baldwin and Shirley (*9*), Smitt (*27*), Oelkers (*22*), Hess (*18*), and Champion (*14*) give many examples of the unwise and hasty use of foreign and non-local seed. Fankhauser in particular makes a very strong statement of the situation as it exists in Europe. Enough of this evidence has seeped into America to make the existence of climatic races now generally recognized. As early as 1913 Zon (*31*) reported the results of an experiment with Douglas fir seed collected from different regions within its natural range and planted in Europe. The progeny showed distinct differences, depending upon the seed source. Two years later Willis and Hofmann (*30*) evidently recognized the probable existence of such a phenomenon. Eckbo (*15*) in 1916 made a strong plea for the use of local seed. He cited various examples in Europe and reported the existence of separate strains of western yellow pine in Utah and Idaho. Kraebel (*19*) and Wahlenberg (*29*) published on this subject in 1917 and 1921 respectively. In 1926 Roeser (*25*) wrote an excellent article setting forth principles of genetics that should be useful to forestry and made a plea for the use of local seed and for intensive research to develop superior and pure strains of forest trees. Since then Bates (*11*), Baldwin (*8*), Baldwin and Shirley (*9, 10*), and Munger and Morris (*21*) have reiterated, in various ways, the now general belief in the existence of climatic races.

In spite of this general recognition of climatic strains, much confusion still exists regarding the mechanism of their formation, their geographic range, and their importance from a forestry point of view. For example, there is little evidence and less agreement as to the geographical limits of any given strain of a species. Some foresters would not hesitate to plant white pine from relatively low altitudes in Connecticut anywhere in New England or

the middle Atlantic states. Others would want to confine it to approximately the same locality in which it grew. In the Southeast, millions of black locust and shortleaf pine are being planted with practically no regard for seed source. Some black locust seed has been imported from Italy. Added to the confusion regarding geographic limits of climatic strains, there is the apparent inability of many American foresters to become enthusiastic enough about this problem to do more than pay it lip service. European experience has indicated that this attitude is dangerous. It is believed that if the mechanism of the formation of climatic and local strains of trees were better understood by the average forester, he would be in a much better position to appreciate their potential importance and to estimate the probable safe planting range of a given strain. It would serve as a logical basis for reasoning. Without entering into the various controversies of geneticists on this subject a brief, simple description of the more obvious phases of this mechanism will be attempted in the following paragraphs.

The idea of natural selection, in modern times at least, was formulated by Darwin. He assumed that plants and animals vary, that the struggle for existence weeded out the unfit (natural selection) and that these variations were inherited. The well-known work of de Vries and the Danish botanist Johannsen showed that this explanation of evolution was partly incorrect. Darwin did not sufficiently distinguish between different types of variations and assumed that all small variations contributed to evolution. De Vries showed that sudden changes of considerable magnitude are inherited and for that reason may play a part in evolution. In 1903 Johannsen with his famous beans showed that variations in a species population (a natural or heterogenous group) are inherited, but that variations within a pure line are not inherited. He chose, from a heterogenous population of beans, 19 individual seeds ranging in size from the largest to the smallest, and planted them. His results showed that selection for size was effective; that is, the average seed size of the progeny was correlated with the size of the parent bean seeds. However, selection within the progeny of any given bean was not effective. The large beans produced progeny the same size as the small beans; and since beans are always self-fertilized, Johannsen concluded that the variation within the progeny of a single bean was due to environment alone.

There are, then, hereditary variations and variations that are not inherited. The latter are environmental modifications and cannot be utilized by selection. The former, whether large and discontinuous or small and apparently continuous, are attributed to mutations of one sort or another, and can be utilized by selection. These conclusions have been substantiated by many investigators since the classic works of de Vries and Johannsen.

Although the connection between beans and trees may seem obscure, the basic mechanism of the formation of climatic and local races of trees was really discovered by Johannsen in 1903 and de Vries in 1901-3. Their work and that of subsequent investigators has laid a groundwork of genetical science which can be applied to trees. In a heterogenous group (population) of individual trees of a given species, just as with other organisms, two kinds of variations occur; hereditary and nonhereditary. The former are mainly responsible for climatic and local strains. These variations occur not only in physical characteristics, but also in such things as rate of growth, resistance to disease, and tolerance to various environmental factors; the latter being the most important in the present discussion. In a virgin forest community stabilized for many generations, these characters, probably by selection of the variations having high survival value and elimination of the variations having low survival value, have attained a close harmony with the particular climatic and site conditions present. Between this particular forest community and all surrounding communities there is a gradient of the characters. The gradient may have any degree of steepness from marked changes of character within a few miles to almost imperceptible changes over thousands of square miles, depending upon differences in altitude, latitude, soil types, air drainage, influence of proximity of large bodies of water, and probably other factors.

Seed Trees for Natural and Artificial Regeneration

The importance of selecting individuals of superior character for seed trees has been dis-

cussed in this JOURNAL and elsewhere for 25 years or more, yet opinions are sharply divided and no one seems to know just where American forestry is headed in this respect.

In 1910 Sudworth and his committee (*28*) suggested that the improvement brought about by silvicultural treatment created better trees which were capable of transmitting these qualities to future generations. Only in so far as the silvicultural treatment consists of a process of wise selection is this true, and it is not the individual tree that is improved (except as the environment is improved) but the forest as a whole. Pearson (*23*) was concerned only with the quantity and germination of seed from trees of different age and condition. No thought was given to the possible inheritance of undesirable characters. Willis and Hofmann (*30*) found that height growth of Douglas fir for the first two years varied directly with the size of the seed and inversely with rise in altitude of seed source. Age, density of stocking, soundness, soil, and latitude of parent tree showed no correlation with this initial height growth. They conclude that environment is more important than heredity in determining height growth. This may be true, especially for the first two years, but these workers actually made no valid test to determine the effect of heredity on height growth. Altitude of seed source is correlated with growth because of the existence of climatic strains. In the same way soil type might or might not be correlated with the growth of the progeny, depending upon the presence or absence of local strains on the various soil types. For the same reason extreme differences in latitude of seed source would affect the height. It has been shown here and elsewhere (*13*) that size of seed is correlated with the initial growth, but that these differences soon disappear. Age, density of stocking, and soundness of the parent tree are entirely unrelated to the inherent growth rate of a tree. No attempt was made to select seed from trees having an intrinsically high growth rate.

In Britain MacLarty (*20*) pointed out the importance of growing trees from properly selected seed. He emphasized high quality and good health of seed trees, recognition of geographic strains, and age of trees. The latter is not important except that mature trees have survived to maturity, which in itself is a test of strength. There is no reason to suppose, however, as did MacLarty, that overmature trees produce less vigorous offspring.

In America Roeser (*25*) may have been the first forester to point out definitely that susceptibility to disease, vigor, and form were inherited as such. He emphasized the importance of leaving high quality seed trees and of avoiding any practice tending to thin the most vigorous trees from the stand. Boyce (*12*) recognized that trees may inherit a resistance to disease, although he concludes that decayed trees, all things considered, should be left as seed trees. Bates (*11*) recognized the importance of breeding disease resistant strains of trees and cites some proposed experiments. Austin (*1*) described the establishment and early endeavors of the Eddy Tree Breeding Station (now the Institute of Forest Genetics) at Placerville, Calif., and in subsequent articles (*2, 3, 4, 5, 6, 7*) further explained this work. The existence of the Institute is probably well known to foresters. A real effort is being made to develop superior strains of pine, especially fast growing ones, through the application of scientific breeding. Pending specific results from this and other (*26*) sources, foresters can do much to maintain and even improve upon the original excellence of our forests by applying the basic principles of genetics whenever possible.

Oelkers (*22*) and Champion (*14*) give comprehensive reviews of this general subject. Oelkers in 1929 concluded that selection of good stands for seed collection, determination of a strain according to climate and soil, and elimination of poor specimens by thinning were three practical measures that could and should be put into practice immediately. Champion's survey of this field of information includes a review of 150 publications and conversations with workers in the field and is probably the most complete ever attempted. Hasel (*17*) gives a summary of the conclusions reached by Champion. It is sufficient to say that they agree very well with conclusions previously reported by geneticists working on almost everything, except trees.

Righter (*24*) states that the vigor of trees is affected by hereditary influences. He makes it clear, however, that both heredity and environment are causative agents and often difficult to separate. Smitt (*27*) takes for granted the

existence of climatic and local strains and presents a plan for seed control in Norway which takes into account present available information on the subject. Baldwin and Shirley (*9*) have described the rather excellent program of forest seed control in Europe and in a later article (*10*) have proposed a workable plan to handle the problem of geographic strains in the United States, but omitted any reference to individual tree characteristics.

The results of a study (*21*) started in 1912 have been recently published by Munger and Morris. As this was a pioneer effort considerable credit is due those responsible for it. Some of the conclusions, however, may be premature and somewhat misleading. The experimental trees were about 20 years of age at the time of observation, which is roughly one-twentieth of the life span of Douglas fir. Other organisms do not show all their inherited traits in the first five percent of their life span. Statements such as the following may be questioned: "Any old misshapen trees that would not return more than the cost of logging should be left, if they are good seed producers." "Any old misshapen tree" may or may not be a good seed tree. If the "misshapenness" is definitely due to environment only and the tree is otherwise desirable, its offspring should be acceptable in every way. But poor form is also inherited; and until we can distinguish between inherited effects and environmental effects it seems best to assume the possessor of "misshapenness" guilty of inferior germ plasm.

It is further recommended in the same paper that young trees, too small to be cut, be left for seed trees. This is easier to defend. There is no evidence to show that the age of an individual tree or other organism affects the nature of its genes. European practice, however, stipulates that seed trees must have reached a certain minimum age. This is merely to give natural selection a longer time to weed out and indicate the unfit. It is probably a reasonable practice and deserves application in this country.

The results of the experiment showed that progeny of trees growing on a particularly poor site were as vigorous as any. This area was formerly nonforested and the seed used in the experiment came from one of the first generations developed there. It has been pointed out previously that local strains develop only in stable forest communities after many generations of natural selection. The present example is probably not a fair test. It can be stated beyond reasonable doubt that local races due to marked differences in soil do exist and that seed from a poor soil strain planted in a good soil would never grow as large as the native trees. The same thing applied to "dry" and "wet" site strains.

The results further indicated that density of stocking of the mother trees had no effect upon the vigor of the progeny. It is axiomatic that density, in itself, could not affect the heredity constituents of an organism. There is something to be said, however, for the more rigid selection imposed upon dense-grown trees as opposed to open-grown trees. The form of bole and crown is known to be inherited to some extent (*13*). It is perhaps a reasonable assertion to state that those trees having an inherited tendency to wide crowns and perhaps short, crooked stems are more likely to be eliminated in a dense than in an open-grown forest.

It is definitely known that in living organisms resistance to disease is inherited and trees are no exceptions (*13*). This is probably recognized by Munger and Morris, but there appears to be some misconceptions. The test for conky versus sound seed trees was health and vigor of the respective progeny at 20 years of age. It is apparently assumed that the fungus weakens the tree and that this weakness is passed on to its progeny. There is considerable doubt that this occurs. Even a parasitic disease does not affect the germ plasm of an organism. An observation of vigor at 20 years of age as between conky versus sound parents probably has little meaning and it is obviously impossible to observe resistance to heart rot on trees of that age. The mechanism of disease resistance is usually connected with living protoplasm and for this reason there is some doubt regarding the inheritance of susceptibility to heart rot. It is possible, however, that the make-up of the heartwood influences, to some extent, its resistance to the fungus; and this make-up may be inherited.

It is very encouraging to note that out of 13 localities from which the seed trees were selected the progeny from two of these groups seemed definitely superior to the other eleven. These strains also showed a wide range of

adaptation and are apparently definitely superior. Unfortunately the exact location where they grew is not now known, and the trees themselves have been cut or lost. It is still possible, however, to collect seed from the progeny for planting and experimental work. It is too good an opportunity to miss.

Selection of Seed Trees

The following remarks are confined to individual tree characteristics. Climatic and local strains are of the utmost importance in artificial regeneration of forests; but this has already been discussed, and it must be taken for granted that American foresters are now aware of the significance of this subject. There is still much experimental work needed to show the geographical and altitudinal limits beyond which it is unsafe to move the various races. Baldwin and Shirley (*10*) give a few helpful rules and even a rough understanding of the mechanism of local race formation should supply some basis for decision.

In any consideration of seed tree selection, the first and paramount question is the one between heredity and environment. Due to the difficulty or impossibility of distinguishing between the two in many cases, the selector is left with four alternatives;

1. Assume all characteristics such as growth rate, ultimate size, form of bole and crown, forkedness, and disease resistance, as due to environment only. In application this leads to the leaving of culls for seed trees and indiscriminate collection of seed from the most accessible trees. This assumption seems all too prevalent in America.
2. Assume all characteristics due to environment except the few that are definitely and plainly a result of inheritance.
3. Assume all characteristics due to heredity and select seed trees accordingly. This is "playing safe." European practice tends toward this assumption.
4. Make a real effort to distinguish between the effects of heredity and environment, but in case of doubt be conservative and assume the characteristics of the tree inherited. This is perhaps the ideal way.

Besides the characters just mentioned, the following can almost certainly be inherited (*13, 14*); hardiness, drought resistance, tolerance to environmental factors in general, adaptability, curly and birdseye grain, character of wood in general, thickness of bark, and size, color, and form of fruit and other minor structures. The part of the tree from which seed is collected, age, size of seed, density of stocking, mechanical injury, and disease, cannot, *in themselves*, influence the germ plasm in any way. As mentioned previously, however, age and density may exercise a selective action and resistance or susceptibility to at least some disease can be inherited.

Artificial selection based only upon outward (phenotypic) characteristics does not, of course, remove all inferior germ plasm. Many genes for inferior characters are carried as recessives in superior individuals and become manifest only in a due proportion of times. This partly explains why many ages of natural selection have not entirely eliminated defective germ plasm from the forests. It is particularly poor practice to utilize defective seed trees. The germ plasm is very likely to be homozygous for that character and if self fertilized or propagated by asexual means, all progeny would carry the defect as a phenotypic characteristic. It can be stated beyond reasonable doubt that the utilization of culls as seed trees, either for natural or artificial regeneration, will result in poor quality forests. The utilization of superior seed trees will at least maintain the forests at their present standard and probably cause some improvement.

In concluding these remarks, I want to make a simple plea in behalf of future generations, both of people and of forests. These things are real, not imaginary. These characters *are* inherited; these races *do* exist; and any practice of large scale retrogressive selection will lower the quality of our forests just as certainly as it would lower the quality of potatoes, cattle, or human beings. This can be avoided by the constant application of the knowledge of genetics now at our disposal and by further research to show us how to apply this knowledge to the forests.

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A YIELD TABLE FOR WELL-STOCKED STANDS OF BLACK SPRUCE IN NORTHEASTERN MINNESOTA

By G. D. FOX and G. W. KRUSE[1]

U. S. Forest Service

Black spruce (*Picea mariana*), one of the most important conifers in northeastern Minnesota, is distributed widely throughout the northeastern United States and much of Canada. It is characteristically a very tolerant and slow-growing species which occupies poorly drained or swampy sites. Since it is a valuable and important species, officers of the Superior National Forest in northeastern Minnesota have believed for several years that a black spruce yield table would be of help in the preparation of management plans. A yield table and a stand table for black spruce, therefore, have been prepared.

BLACK spruce stands, if permitted to develop without disturbance by destructive agencies, tend to become all-aged because of the ability of seedlings to grow in the shade of the parent trees. The spruce stands of northeastern Minnesota, however, have not generally been permitted to reach the final stage because of natural catastrophies, especially the enormous forest fires which apparently have swept over this region during the past two centuries.

The fertile rocky loam soils and cold climate of this locality are so favorable to the growth of black spruce that it commonly occurs not only in peat swamps but also on highland in pure stands or in mixture with jack pine, balsams, aspen, and paper birch. The fact that it grows on high land has subjected it to more damage by fires than if it grew exclusively in the relatively fire resistant swamps.

Hence, the age composition of black spruce forests in northeastern Minnesota varies from all-aged mixtures to even-aged stands. The most

TABLE 1.—STAND TABLE FOR FULLY-STOCKED STANDS OF BLACK SPRUCE (*Picea mariana*)[1] IN NORTHEASTERN MINNESOTA

Av. diam. of dominant stand (Inches)	Crown class[2]	Diameter breast height (Inches) 1	2	3	4	5	6	7	8	9	10	11	12	Av. no. trees per acre
		Percentage of total number of trees in each crown class												
2	D	24.0	64.1	11.6	.3	------	------	------	------	------	------	------	------	2,413
	I	92.0	8.0	------	------	------	------	------	------	------	------	------	------	1,343
	S	99.0	1.0	------	------	------	------	------	------	------	------	------	------	2,188
3	D	.9	27.1	53.5	16.6	1.8	.1	------	------	------	------	------	------	1,732
	I	24.0	70.0	6.0	------	------	------	------	------	------	------	------	------	847
	S	86.8	12.6	.6	------	------	------	------	------	------	------	------	------	1,402
4	D	------	2.4	29.4	43.2	20.0	4.3	.6	.1	------	------	------	------	1,232
	I	2.0	45.0	48.7	4.3	------	------	------	------	------	------	------	------	562
	S	60.0	34.8	4.9	.3	------	------	------	------	------	------	------	------	880
5	D	------	------	4.3	30.7	38.0	20.7	5.2	1.0	.1	------	------	------	888
	I	------	11.5	57.0	29.3	2.2	------	------	------	------	------	------	------	361
	S	38.0	43.3	16.5	2.1	.1	------	------	------	------	------	------	------	548
6	D	------	------	.2	6.3	30.5	35.8	19.7	6.1	1.2	.2	------	------	657
	I	------	2.5	29.5	52.8	14.3	.9	------	------	------	------	------	------	228
	S	24.0	41.0	28.0	6.3	.7	------	------	------	------	------	------	------	380
7	D	------	------	------	.6	8.0	28.4	35.2	19.4	6.5	1.5	.4	------	522
	I	------	.5	11.5	48.0	35.0	4.8	.2	------	------	------	------	------	139
	S	15.3	36.4	33.4	12.7	2.0	.2	------	------	------	------	------	------	246
8	D	------	------	------	------	1.3	9.5	25.5	33.8	20.3	7.2	2.0	.4	426
	I	------	------	4.2	35.8	56.3	2.6	1.1	------	------	------	------	------	80
	S	10.1	31.9	37.7	16.5	3.4	.4	------	------	------	------	------	------	164

[1]Compiled by S. R. Gevorkiantz and G. W. Kruse. Data collected in 1933-36 in the Superior National Forest. Stands are relatively pure and even-aged.

[2]*D*, dominant and codominant; *I*, intermediate; *S*, suppressed trees.

[1]District ranger and junior forester, respectively, Superior National Forest.

Table 2.—Yield Table for Fully-Stocked Stands of Black Spruce (*Picea mariana*) In Northeastern Minnesota[1]

Per acre

Age (Years)	Crown class[2]	Av. d.b.h. of dominants (Inches)			Height of av. dominant (Feet)			Number of trees Site quality[4]			Basal area (Sq. Ft.)			Merchantable volume (Cords)[3]		
		G	M	P	G	M	P	G	M	P	G	M	P	G	M	P
20	All trees	2.2	1.4	0.8	17	14	11	5,741	----	----	84	.	..	----	----	----
	D							2,348	----	----	61	----	----	----	----	----
	I							1,290	----	----	12	----	----	----	----	----
	S							2,103	----	----	11	----	----	----	----	----
30	All trees	3.4	2.4	1.6	26	22	17	3,478	5,310	----	129	91	----	8	1	----
	D							1,540	2,210	----	99	67	----	8	1	----
	I							738	1,160	----	19	13	----	----	----	----
	S							1,200	1,940	----	11	11	11	----	----	----
40	All trees	4.2	3.2	2.3	33	28	22	2,529	3,675	5,502	149	123	86	17	6	----
	D							1,175	1,680	2,272	115	93	64	17	6	----
	I							532	760	1,220	22	18	12	----	----	----
	S							822	1,235	2,010	12	12	10	----	----	----
50	All trees	4.9	3.9	2.9	39	33	26	1,957	2,916	4,338	159	142	110	26	14	3
	D							950	1,324	1,851	125	109	84	25	14	3
	I							400	617	921	22	21	16	1	----	----
	S							607	975	1,566	12	12	10	----	----	----
60	All trees	5.5	4.5	3.3	44	37	29	1,520	2,350	3,575	162	155	123	32	22	6
	D							772	1,106	1,580	129	120	94	30	21	6
	I							297	488	760	21	23	18	2	1	----
	S							451	756	1,235	12	12	11	----	----	----
70	All trees	6.0	4.9	3.7	49	41	32	1,277	1,957	3,077	153	159	136	37	27	12
	D							667	950	1,387	132	124	104	34	25	12
	I							238	400	650	20	23	20	3	2	----
	S							372	607	1,040	11	12	12	----	----	----
80	All trees	6.3	5.20	4.1	52	44	34	1,157	1,714	2,691	164	161	146	41	31	16
	D							620	853	1,238	135	127	113	37	29	16
	I							207	343	568	18	22	21	3	2	----
	S							330	518	885	11	12	12	1	----	----
100	All trees	6.9	5.7	4.5	58	48	38	959	1,422	2,275	166	162	155	47	36	24
	D							542	730	1,080	140	130	119	43	33	23
	I							154	272	475	16	20	33	3	3	1
	S							263	420	720	10	12	13	1	----	----
120	All trees	7.3	6.0	4.8	62	52	41	849	1,277	1,985	168	163	158	52	40	27
	D							500	667	965	145	132	124	48	37	25
	I							122	238	402	14	19	22	3	3	2
	S							227	372	618	9	12	12	1	----	----
140	All trees	7.6	6.3	5.0	65	54	43	775	1,157	1,837	169	164	160	54	43	30
	D							470	620	905	148	135	126	50	39	28
	I							105	207	372	13	18	22	3	3	2
	S							200	330	560	8	11	12	1	1	----
160	All trees	7.8	6.5	5.2	67	56	44	748	1,086	1,714	170	166	161	56	45	31
	D							460	595	853	151	138	127	52	41	29
	I							98	185	343	11	18	22	3	3	2
	S							190	306	518	8	10	12	1	1	--
180	All trees	8.0	6.7	5.3	69	57	45	688	1,022	1,626	170	167	161	57	47	32
	D							433	568	821	153	140	128	54	43	30
	I							84	170	322	9	17	22	2	3	2
	S							171	284	483	8	10	11	1	1	

[1]Data collected 1933-36 in Superior National Forest, under supervision of Gordon Fox. Table compiled at Lake States Forest Experiment Station by G. W. Kruse.

[2]*D*, dominant and codominant; *I*, intermediate; *S*, suppressed trees.

[3]Unpeeled merchantable volume, standard cords, Table 120, Univ. Minn. Tech. Bull. 39, revised edition, 1934.

[4]*G*, good; *M*, medium; *P*, poor.

frequent types of stands from which the yield table data were gathered[2] were "two storied"; that is they contained a fairly even-aged dominant overstory and an understory of smaller trees, part of which were of the same age-class as the overstory and part of which were considerably younger. No attempt was made to use data from very uneven-aged stands.

Because of the somewhat uneven-aged character of the stands, the usual procedure for constructing yield tables could not be expected to give very accurate results. Since the smaller trees were often younger than the larger ones, and hence had developed somewhat independently, the data from the field plots were sorted into three groups based on crown classes: dominant and codominant, intermediate, and suppressed. Each of these three sets of data were treated separately, but the computation work was conducted much the same as for the usual type of yield table. The final tables (Table 1 and 2) are really composites of three separate sets of calculations and curves.[3]

The separation of the crown classes in the tables serves three purposes: (1) it recognizes and calls attention to the somewhat lower age of the smaller trees; (2) it calls attention to the fact that suppressed and intermediate trees possibly may sometime become dominants, rather than slowly dying out as in the case of intolerant species; and (3) it shows how spruce stands can support extremely large numbers of small trees and still have enough large trees to yield a fair amount of merchantable volume. This information may prove useful in deciding upon ways to cut and manage the stands.

It should be noted that the new tables have been named "Yield tables for *Fully-Stocked Stands*" rather than "Normal Yield Tables." This distinction was made because almost all the data were gathered within the relatively small area of two and one-half million acres, and it is known that many of the finest stands have been logged off so that there is considerable likelihood that the best sites of the mature stands were not properly sampled.

Table 2 shows unpeeled volume in standard cords (close piling) of trees 4 inches and larger in diameter breast high. It assumes that the trees are cut into 8-foot sections above a 1-foot stump to a top diameter of 3 inches inside of bark. No allowance has been made for defect, shrinkage, or other losses.

The writers believe that a rather novel use possibly can be made of the tables in connection with thinning operations. The U. S. Forest Service practice for noncommercial thinning in young jack pine in the Lake States Region consists of reducing the number of stems to that of a normally stocked stand ten years older. The trees to be left are selected upon the basis of size, vigor, and uniform spacing. This results in leaving very uniform stands which contain few or no understory trees.

If the same method were to be applied to black spruce it would result in practically no thinning in the upper crown canopy among the larger trees where it is desired to stimulate growth. On the other hand, experience has shown that when all the smaller trees and part of the larger ones were removed, the remaining trees were very susceptible to snow and wind damage. It appears reasonable to propose that each of the three crown classes should be thinned separately in order to stimulate the growth of the larger trees without creating unnecessary exposure and to maintain natural growing conditions. The new tables could, of course, be used for preserving the proper distribution of sizes and for estimating the degree of thinning in each of the crown classes.

The application of these composite tables may bring to light additional advantages not yet pointed out. In the same manner the management of various other valuable tolerant species might be aided by similarly constructed tables.

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[2]The field data were gathered by Jos. Lozinski and Clifford Coles. The preliminary computations were made by Mr. Coles.

[3]The writers wish to acknowledge the assistance of S. R. Gevorkiantz of the Lake States Forest Experiment Station who suggested that the data be worked up separately for each crown class.

IMPROVEMENT CUTTINGS IN SHORTLEAF AND LOBLOLLY PINE

By R. R. REYNOLDS
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The following article shows that improvement cuttings in shortleaf and loblolly pine are profitable. The author, who had charge of the improvement cutting, shows how profitable these operations were and gives his recommendations as to how these cuts should be made. Many foresters will be interested to learn that improvement cuttings are economically feasible in the South and that they are being practiced by private companies on a commercial basis.

ALL stands of timber, regardless of whether virgin, old field, or second growth, contain a certain number of "weed" trees that should be removed in order to make room for good crop trees. In many stands, 25 to 75 percent of the ground area is occupied by such trees.

During the past several years at Crossett, Ark., the Southern Forest Experiment Station has been working on selective-logging studies, pulpwood production-cost studies, and improvement-cutting studies, all in second-growth timber. Based upon the general results of these studies, I am of the firm opinion that timber growing in the future holds as much, or more, promise of profit as did the purchase and milling of virgin timber in the past. But one of the first measures required of forest owners who wish a good net income from their forest holdings, is to get the "weeds" out of their crop. Most owners do not realize that, in the shortleaf-loblolly pine type, a stand or growing stock equivalent to about 1,100 board feet per acre is necessary to produce sufficient growth to pay expenses. Therefore, if a timberland owner has 100,000 acres of timber, including many "weed" trees, in addition to a growing stock of only 1,100 feet of merchantable timber per acre, his only compensation is the fun of handling this property without it costing him anything. If, however, he disposes of the worthless and low value trees and builds up the growing stock, for example, to 5,000 board feet of high-quality trees per acre, then he may have to worry about spending an annual income of $150,000 per year. There is no magic needed to make money in timber growing. In fact, it needs nothing more than a bit of good, uncommon sense along with a little capital.

The success in improving stands by cutting depends upon the knowledge and skill of the owner, or manager, in determining which trees to cut and which to reserve for future growth. It must be realized, of course, that no hard and fast rules for marking can be set up, and that on a particular property the decisions as to which trees to cut must be made on the ground. A good rule to follow, unless economic necessity requires a heavier cut, is to mark only those trees that either are "financially mature" or are interfering with the growth and development of more valuable individual trees. Many people think that financially mature trees are only large mature ones, but in reality, financially mature trees may be of nearly any size and age, from 2 to 40 inches in diameter and from 10 to 300 years of age. A financially mature tree is one that because of location (perhaps under a large overtopping tree), or because of rot, crook, limbiness, or age, is either decreasing in value each year, or is not growing in volume or quality at a rate sufficient to produce a net return above the yearly cost of carrying this tree in the stand. We may list among these financially mature trees:

1. Badly suppressed trees, which are certain to go out of the stand within the next five years through natural mortality.
2. Trees that because of the crooked condition of the bole will never produce saw timber. Fast-growing, crooked trees that contain, or will contain, pulpwood should be left for additional growth if they do not interfere with the development of more valuable trees.
3. Trees that show unmistakable evidence of red-heart or other tree destroying fungi.
4. Trees that contain fire scars sufficiently severe to make them susceptible to wind damage.
5. Extremely brushy or limby trees, which will never produce lumber of average quality better than grade No. 2C, and which will become less valuable for pulpwood or cordwood as more limbs develop.
6. Limby trees that will never produce at least one No. 2 sawlog should be removed if this interferes with more valuable trees.

After determining which trees are "weeds," the next problem is to get rid of them. Should we attempt to girdle them all, cut all of them for pulpwood and fuelwood, or cut only those that

will "pay their way" and leave or girdle the others? With new markets developing, e.g., for pulpwood, a "high, wide, and handsome" girdling operation can hardly be recommended. On the other hand, cutting of pulpwood or fuelwood at a loss cannot be justified. Every effort should be made to find profitable markets for pulpwood, fuelwood, chemical wood, ties, posts, bolts for box boards and handle stock, or for any other of a possible 100 products; and then should be cut only those trees that will yield a profit.

We have made large-scale improvement-cutting studies on the Crossett Experimental Forest in the shortleaf-loblolly pine type to determine if such improvement cuttings can be made without cost. We have kept accurate cost records on the cutting on about 400 acres of second-growth timberland and also on enough trees of the various species to determine what type of tree cannot be cut at a profit into any salable product. We first cut the pines on the various areas and determined the cost and profit, and then from the same areas cut the hardwoods. The defective or low-quality pine was cut into pulpwood at the following cost per 144 cubic feet:

Marking cost, including paint	$ .035
Oil, wedges, saws, saw-filing	.115
Labor	1.030
Total	$1.180

The value in the woods on part of the wood produced on this cutting was $1.50 per 144 cubic feet, and on this unit we made a net profit of $0.32. When the study was about half completed, the value of the wood increased to $2 per unit f.o.b. the woods; therefore, on about half the material we made a net profit of $0.82 per unit. We obtained an average of 1.35 units of pulpwood per acre from this cutting, or a net income of $1.11 per acre with pulpwood at $2 per unit.

After cutting the low-grade pine from the area we made an improvement cutting of the hardwood portion of the stand and sold the material for chemical wood. The cost of this cutting per 138 cubic feet was as follows:

Marking cost, including paint	$ .035
Oil, wedges, saws, saw-filing	.115
Labor	1.590
Total	$1.740

The value in the woods of most of the chemical wood we have produced has been $2 per 138 cubic feet; therefore, our profit on this unit has been $0.26. We were fortunate in having a chemical-wood market that others might not have. Other markets, however, were available for this material; in fact, we developed a wood market that became so good that we could not fill the demand. A market is also available for low-grade hardwood logs to be cut into ties, timbers, and lumber. We thus had several chances to sell most of this low-grade material. As mentioned before, we made a study of the cost of production for all sizes and classes of trees, and as soon as we had determined definitely that we were losing more money on certain trees than it cost to girdle them, we stopped cutting them.

Except for the large and extremely rough trees with large branches clear to the ground, from some of which it was practically impossible to split the bolts, we made a profit on all pines 4 inches d.b.h. and larger which had at least two sticks of pulpwood. In the hardwood portion of the stand, however, we had no market for red and black gum of low quality. We also lost money on large and very rough oak of several species and on most hickory. Furthermore, it was generally not profitable to cut hardwoods below 7 inches d.b.h. into either chemical wood or fuelwood. On the remainder of the hardwoods we made a reasonable profit.

What disposal can be made of the red and black gum and the extremely rough and limby pines and hardwoods remains a problem. Since a market for both red and black gum for pulpwood, posts, and piling promises to develop in the near future, it seems desirable to save these trees until the market develops or until we are sure that a market will not be available. If we save the gums, we then have per acre only about two financially mature trees out of the 10 to 20 with which we started. It is often suggested that timberland is cheap and that instead of girdling large wolf trees we should let them stand and buy more land. In some cases this may be a good practice, but each tree usually occupies at least one-tenth of an acre of ground and girdling usually costs less than 5 cents a tree. If an acre were fully occupied with such trees, it would thus cost a maximum of 50 cents an acre to girdle. Where can other land be bought for 50 cents an acre?

It is not always necessary or advisable to carry on the improvement cutting entirely separate

from other types of cutting. If this work is to be done under contract, it is much simpler to have it follow immediately a sawlog or other cutting and to have both operations done by the same contractor. By handling both cuts, the contractor not only can add a few butt logs from the cull trees to his sawlog cutting, but he also can add the topwood from saw timber trees to the pulpwood cut during the improvement cutting.

In conclusion it may be stated that our studies of improvement cuttings in both pines and hardwoods indicate that such cuts are immediately profitable and furthermore that they leave the stands in such a condition that they will later produce a greater volume of a higher quality and value. Our results also have been substantiated by several large companies, following similar practices, but in strictly commercial operations on much larger areas.

LOBLOLLY PINE VERSUS COTTON: A COMPARISON OF ANNUAL CELLULOSE PRODUCTION PER ACRE

By HENRY BULL

Southern Forest Experiment Station

One of the great changes that has occurred during recent years in the cellulose utilizing industries has been the substitution of wood cellulose for cotton cellulose. Wood cellulose now competes with cotton cellulose in the manufacture of many cellulose products. The author shows that, on Arkansas soils, only moderately productive for cotton, loblolly pine produces about 4.5 times as much cellulose per acre as does cotton. Differences in processing costs, production costs, and markets also are discussed briefly.

Two recent bulletins[1] afford the basis for an interesting comparison of the cellulose production of loblolly pine and cotton on identical soil types in Arkansas. Table 1, derived from these two bulletins, gives the fundamental data. Table 2, which classifies the productivity of soils on the basis of their average yields of lint cotton, shows that all the soil types listed in Table 1 are only moderately good for cotton production.

According to these tables, loblolly pine has an average site index of about 90 on soils that are only moderately productive for cotton and that yield an average of only 145 pounds of lint cotton per acre. Now loblolly pine on a 90-foot site will average 1.54 rough cords per acre per year for 35 years, the age of culmination of mean annual growth in cords.[2] Using a converting factor of 80 cubic feet of solid wood per cord, this amounts to about 123 cubic feet of solid wood per acre per year. Since the specific gravity of loblolly pine is 0.47, based on green volume,[3] 1 cubic foot of dry wood weighs about 29.4 pounds. Thus 123 cubic feet weigh about 3,616 pounds. Wood contains only about 45 percent usable cellulose,[4] however, and thus the annual yield of cellulose from loblolly pine is about 1,627 pounds per acre. Since 1,627 (the annual yield of pine cellulose) divided by 145 (the annual yield of cotton cellulose) equals 11.2, loblolly pine produces about 11 times as much cellulose per acre per year as does cotton.

This conclusion is based (1) on fully stocked stands of pine; (2) on soils only moderately productive for cotton; (3) on the maximum growth per acre per year shown in the loblolly pine yield tables for the site represented by these soils; and (4) on actual average yields of lint cotton over a period of years. The average cotton yields were "produced under conditions apparently suitable although not necessarily optimum." While some of the soil types considered are usually inadequately drained, it is implied either

[1]Turner, L. M. Some profile characteristics of the pine-growing soils of the Coastal-Plain region of Arkansas. Ark. Agric. Exp. Sta. Bull. 361. 1938.

Bartholomew, R. P., and O. R. Younge. Relative productivity of soils in Arkansas. Ark. Agric. Exp. Sta. Bull. 365. 1938.

[2]Volume, yield, and stand tables for second-growth southern pines. U. S. Dept. Agric. Misc. Pub. 50. 1927.

[3]U. S. Dept. Agric. Wood handbook, 1935.

[4]The *total* cellulose content of wood is about 60 percent, but according to the U. S. Forest Products Laboratory the average yield of *usable* cellulose from chemical pulping is only about 45 percent.

TABLE 1.—PRODUCTIVITY OF ARKANSAS SOILS FOR COTTON AND FOR LOBLOLLY PINE

Soil type	Average yield of lint cotton per acre[1]	Range of site index of loblolly pine[2]
	Pounds	Average dominant height at 50 years
Lufkin silt loam	155	80- 89
Ochlockonee very fine sandy loam	151	108
Montrose silty clay loam	150	72
Caddo fine sandy loam	149	83- 86
Waverly very fine sandy loam	146	65
Ruston fine sandy loam	144	82- 89
Amite fine sandy loam	143	103
Ochlockonee fine sandy loam	142	100-108
Bibb very fine sandy loam	141	77- 98
Kalmia fine sandy loam	141	91- 97
Caddo silt loam	139	82- 99
Ochlockonee silt loam	138	91-109

[1]From Relative productivity of soils in Arkansas. Ark. Agric. Exp. Sta. Bull. 365. 1938.

[2]From Some profile characteristics of the pine-growing soils of the Coastal-Plain region of Arkansas. Ark. Agric. Exp. Sta. Bull. 361. 1938.

that the drainage conditions were improved or that the cotton was grown on areas which were better drained than the average for those particular types. On the other hand, the cotton yields presumably are based on both good and poor farming practices and do not represent merely the best farming practice.

Under these circumstances, it is perhaps fairer to use for comparison the average growth per acre per year actually being made by pines in the loblolly pine region of Arkansas. Recent figures from the Forest Survey[5] show that for southwest Arkansas—west of the Mississippi River bottomlands and south of the Ouachita Mountains—the actual average growth in 1936, expressed in cords for pines in all pine types and conditions, was approximately 40 percent of the maximum yield-table value given above. On this basis, loblolly pine produces about 4.5 times as much cellulose per acre per year as does cotton.

There are a number of points that must be taken into consideration in evaluating the significance of these comparisons. Cotton cellulose, for example, is processed more cheaply than pine cellulose, but is grown at a much greater cost. Pine cellulose is produced without annual planting and cultivation, without use of fertilizers, and under comparatively low taxes. Differences in the portions of each plant that are currently merchantable for cellulose also must be considered. Experiments in the use of the entire cotton plant for cellulose are in progress, but at the present time the proportion of merchantable material is lower in the cotton plant than in loblolly pine. Cotton cellulose and pine cellulose are also very different substances and have very different qualities and uses. The comparisons that have been made here, therefore, are comparisons only in terms of weight and not in terms of quality or value; unless this is kept clearly in mind, the comparisons will be misleading. Even with all these limitations in mind, however, the much greater production of cellulose by loblolly pine seems to warrant consideration and study by foresters, cotton-growers, technologists, and economists.

[5]Forest resources of Southwest Arkansas. Southern Forest Exp. Sta., Forest Survey Release No. 27, 1937.

TABLE 2.—GROUPING OF SOILS ACCORDING TO THE AVERAGE RELATIVE YIELD OF LINT COTTON PER ACRE, IN POUNDS[1]

Nonagricultural soils, generally suitable only for trees, unproductive	Less than 110
Low productivity	111-135
Moderate productivity	136-155
Good productivity	156-175
High productivity	176-195
Very high productivity	196-215
Exceptionally high productivity	Over 216

[1]From Relative productivity of soils in Arkansas. Ark. Agric. Exp. Sta. Bull. 365. 1938.

SHRINKAGE OF WHITE OAK AS AFFECTED BY POSITION IN THE TREE

By BENSON H. PAUL

U. S. Forest Products Laboratory[1]

This study, together with those previously made on overcup oak, indicate that the shrinkage of the wood increases with its age in the tree; that is, the wood near the center and base of the tree shrinks more in the older trees than in the younger ones. Why that is the case has not been determined, but the indications are that the tendency to collapse, which here is included as shrinkage, increases as the wood grows older, possibly on account of the infiltration of additional material with time in the fine interstices of the pit membranes thereby making them still smaller and more resistant to the withdrawal or rupture of water films in them.

In a discussion of shrinkage of delta hardwoods appearing in the JOURNAL (32: 871-872), it was pointed out that the greatest change in volume accompanying drying took place in the inner heartwood of overcup oak (*Quercus lyrata*) and was partly due to shrinkage and partly to an actual distortion or collapse of the cell structure. It was shown also that there was a general increase in shrinkage from the outer (sapwood) to the inner portion of the trees, not entirely due to the change from sapwood to heartwood as the shrinkage progressively increased in the heartwood all the way to the center of the heartwood, being the greatest in the older trees. A maximum shrinkage as high as 35 percent was found in individual specimens close to the pith.

Subsequent to the study of delta oaks a similar study of several upland species of oak has been made. This latter study included old-growth white oak (*Q. alba*) from the Cumberland Mountains in Tennessee. The trees were 230 to 290 years old and averaged 29 inches diameter breast high. The volumetric shrinkage values for five of these old-growth Cumberland Mountain oaks when arranged according to the position of the samples in the trees, like the delta overcup oak, showed a progressive increase in shrinkage from the circumference toward the center of the trees, the highest shrinkage being found near the center in the lower part of the older trees. The increase in shrinkage toward the pith of these trees was so regular that it was possible to make a shrinkage map, or diagram, from the composite shrinkage values showing zones of progressively greater volumetric shrinkage from the outer to the central portion of the trees (Fig. 1).

From this diagram it may be seen that the volumetric shrinkage of the outer zone (sapwood) was less than 15 percent (the minimum value was 10.5). Within are other zones showing an increase in shrinkage toward the pith. The second zone of the diagram shows the portion of the trees having a shrinkage range of 15 to 18 percent; the third zone, of 18 to 21 percent shrinkage, the apex of which is not shown, reaches the pith at the top of the fourth log, or 64 feet above the stump; the fourth zone, 21 to 24 percent shrinkage by volume, occupies the central portion of the trees from 29 to 64 feet above the stump and extends downward around a fifth zone of over 24 percent shrinkage ranging up to a maximum of 30 percent, which comprises a cone in the center of the trees. The base of this central cone was about 9 inches in diameter.

In addition to the old-growth upland oaks studied, the volumetric shrinkage was determined for 38 second-growth white oak trees 50 to 80 years of age representing seven localities of the southern Appalachian region. Samples from these second-growth trees did not show any definite zonation of shrinkage from the circumference to the center of the trees. Also, the range of volumetric shrinkage in the second-growth

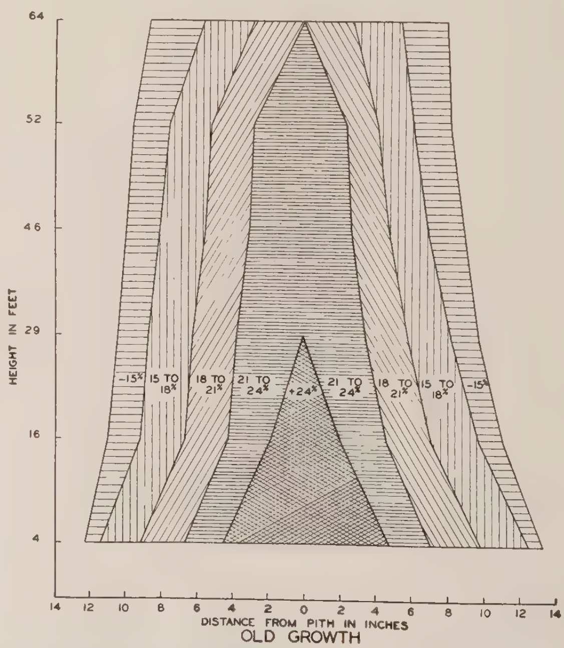

Fig. 1.—Zones of progressive shrinkage increase toward the pith in old-growth, upland white oak. Based on composite shrinkage values from five trees.

[1]Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

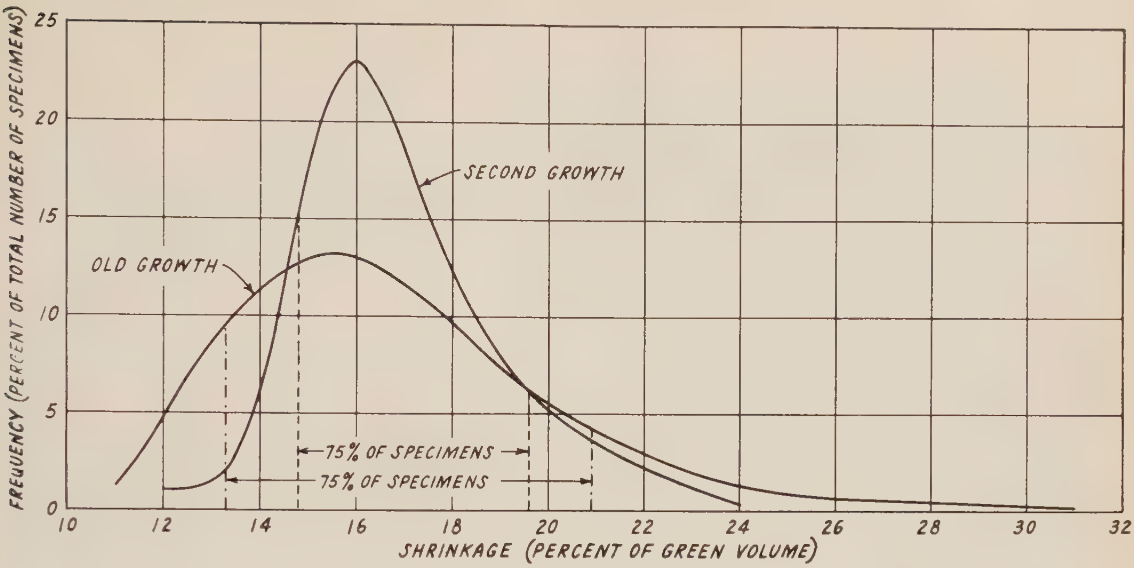

Fig. 2.—Variability in volumetric shrinkage in old-growth and in second-growth, upland white oak.

trees was considerably smaller than in the old-growth trees as is shown by the variability curves in Figure 2.

In the second-growth trees the wood having the highest volumetric shrinkage was contained in the samples taken from the sections 1 foot in length cut just above the stump. Seventy-five percent of the specimens shrinking 18 percent or more by volume came from this position in the trees. The maximum shrinkage was 24 percent. Only 0.9 percent of the specimens originating 4 feet or more above the stump had a shrinkage value of 18 percent or more. This places a high percentage of second-growth white oak lumber in that part of the trees devoid of excessive shrinkage.

For example, Figure 2 shows that the middle 75 percent of the 1,484 specimens from the 38 second-growth trees had volumetric shrinkage values between 14.8 and 19.6 percent, a range of 4.8 percent. In the ten old-growth trees, the middle 75 percent of 635 specimens had a shrinkage range between 13.3 and 20.9 percent by volume, a range of 7.6 percent.

The shrinkage behavior of old-growth and second-growth white oak does not closely follow the accepted theory that the heavier wood shrinks more than lighter wood since the specific gravity of second-growth white oak averaged 12 percent heavier than old-growth white oak (Fig. 3), therefore the shrinkage of the wood from second growth might be expected to be considerably higher than that of old growth. As a matter of fact, old growth with an average specific gravity of 0.58 and second growth with an average specific gravity of 0.65 had approximately the same average volumetric shrinkage, 17 percent.

Although it appears likely that as a rule the wood of second-growth white oak will be found to be heavier than much of the old-growth material, there is a distinct advantage with respect to lower shrinkage on account of the relatively young heartwood. At one extreme the second-growth timber will lack the highly prized soft-textured material which comprises the outer low shrinkage zones of the virgin-growth trees and at the other extreme material of unusually high shrinkage from the older heartwood of the old-growth trees likewise will be absent.

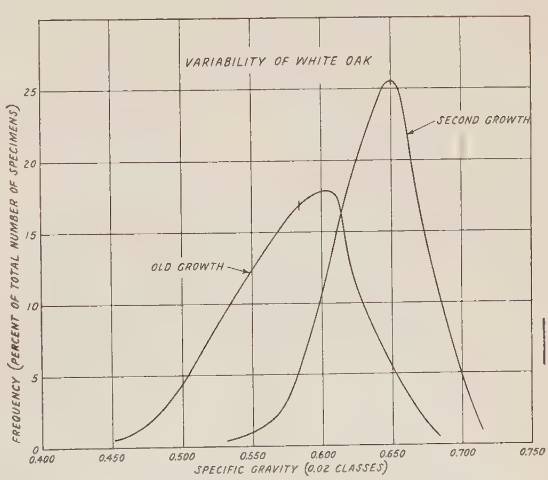

Fig. 3.—Variability in the specific gravity of old-growth and second-growth, upland white oak.

A SIMPLE METHOD OF MAKING GERMINATION TESTS OF PINE POLLEN

By F. I. RIGHTER[1]

California Forest and Range Experiment Station

Forest tree genetics is a relatively new development in the United States. During recent years interest in the field has increased rapidly. New techniques are now being devised at various research centers to expedite the work. The determination of the viability of pollen is often a slow and laborious routine test. The following article describes a simple, effective, rapid, and accurate method for determining pollen viability.

NUMEROUS pollen germination tests are a requisite of breeding work with pines. In order to avoid futile efforts in making controlled pollinations, designated pollen supplies must be tested for viability prior to their use. Therefore it was necessary to devise a reliable pollen-germinating method that would accommodate heavy, current requirements. The method herein described grew out of experiments arising from that need.

Since most features of the method have been used successfully for several years in making routine viability tests, its capacity and reliability for that purpose have been fairly well tested. It seems probable that it will also accommodate investigations into the effects of hereditary and environmental factors upon development because it provides for expanding the "hanging-drop" method within the same germination chamber so as to take the form of paired tests, Latin squares, or other recommended arrangements, and thereby fulfill the sampling requirements of such tests.

Recent inquiries as well as growing interest in forest genetics suggest that it, or some of its parts, may be useful to others; therefore its chief features are presented in this paper.

Preparation of the Germination Chamber

Melted paraffin is poured into the warmed bottom of a Petri dish so that the horizontal surface is covered uniformly to a depth of two or three millimeters. Small areas about four millimeters square are freed from the paraffin by scraping with a small, sharp, sterile instrument during the solidification of the paraffin. If the holes are made after solidification the paraffin may fall away from the glass during the test. Other substances such as vaseline, a mixture of equal parts by weight of vaseline and beeswax, or a mixture of vaseline, paraffin, and beeswax may be used. Vaseline is not recommended because it yields streaked plates, it is not easily manipulated, and one set-up will serve for only one test. If the mixtures are used the holes may be made after solidification takes place.

The function of the holes thus made is to hold the germination cultures (hanging-drops) against clear glass and prevent them from running together. They can be located and made roughly by hand, or mechanical aids such as a stencil and a needle may be used to outline them in the paraffin. A ruler resting on the dish will serve to guide the hand while scraping the soft paraffin aside or while cutting it after solidification has taken place.

After the holes have been made the rows and columns are designated by letters and numbers written in the paraffin with a pencil. Such designation provides for orientation and thus facilitates the establishment of the test in accordance with an experimental design. Figure 1 illustrates simple means of providing for orientation.

A few drops of distilled water are then placed in the top section of the Petri dish, to the inside periphery of which a five-millimeter band of melted vaseline has been applied with a small brush or a medicine dropper. The purpose of the water is to maintain the humidity of the culture chamber at a point where evaporation of the culture drops will not occur. The vaseline band forms a seal for the chamber.

Preparation of the Cultures

Sterile hypodermic syringes, equipped with rubber bulbs instead of plungers and with 15-gauge needles, are used throughout in setting up the cultures. A syringe should be labeled in advance for each lot of pollen or for each treatment that is to be included in the test. Until it is needed for setting up the cultures, each needle should be plugged with a sterile cork.

Vials and flasks, stoppered with cotton plugs, are excellent for use in the laboratory as pollen containers, and the former are well suited for use in the field. Each lot of pollen should be mixed well in its container. The pollen is then drawn

[1]The author is under special obligations to Dr. W. P. Stockwell of this station for criticism and suggestions.

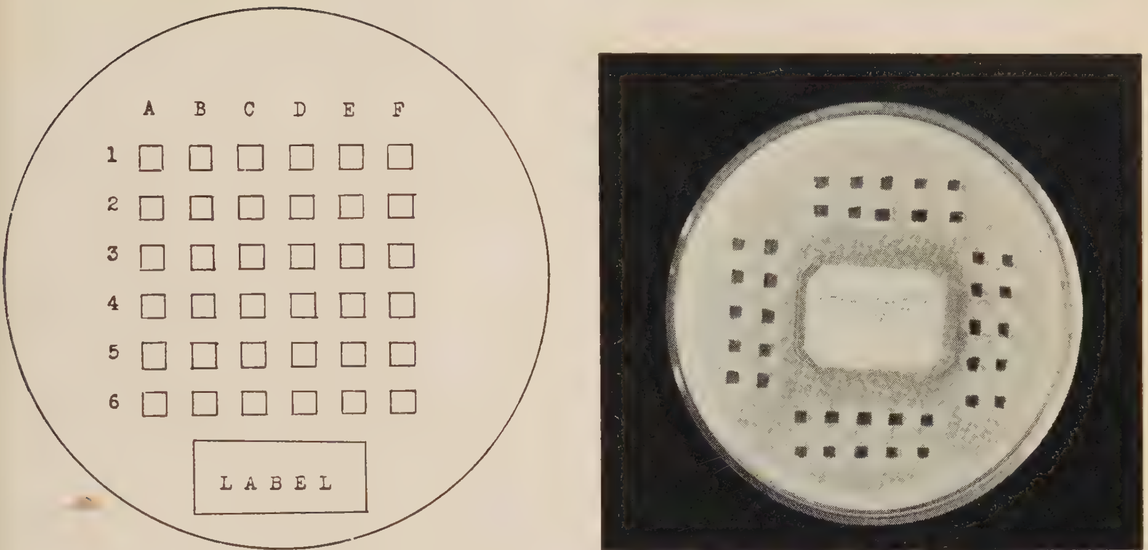

Fig. 1.—Left, diagram of Latin Square arrangement of germination cultures in Petri dish. Right, photograph of paired test arrangement of germination cultures in Petri dish.

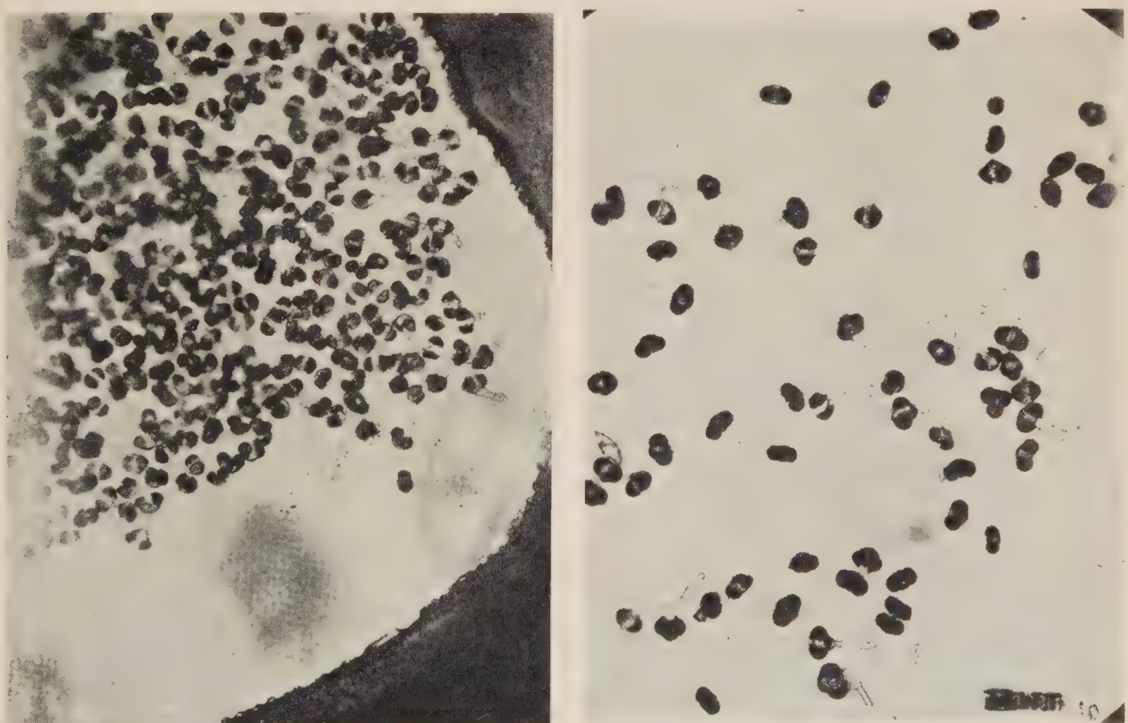

Fig. 2.—Photographs of germination tests of *Pinus ponderosa* pollen. These tests were made one year after the pollen was collected. Left, this culture contains too much pollen. Germination counts and other studies are difficult under such conditions. Vaseline was used in this test. Right, the number and distribution of the pollen grains in this culture are ideal for study. Paraffin was used in this test.

into the syringe without removing the cotton stopper from the container. During this process the needle should be moved so that pollen will be sucked up from different positions in the container. As the needle is withdrawn from the container it should be rotated against the cotton plug so as to remove pollen that may adhere to its outer surface.

Distilled water is an excellent culture medium for pine pollen. It is next drawn into the syringe, where the pollen is mixed with it. After agitating the mixture by shaking the syringe, a drop of the culture is squeezed out into one of the designated holes; this process is repeated until each hole having the same designation has received a drop of the culture. Pine pollen quickly rises to the surface of a liquid if the latter is allowed to become still. Under such conditions, the pollen grains, which vary in size and condition, are probably distributed vertically more or less according to their relative densities. Therefore, if the cultures are to be uniform in size and of random selection, the mixture must be agitated before each culture is pressed out.

From 0.05 c.c. to 0.10 c.c. of pollen will probably suffice for most tests.

The cultures should consist of well scattered pollen grains, since a dense mass of them interferes with germination counts, tube measurements, and other studies (Figure 2). Although the number of pollen grains per drop of medium cannot be controlled precisely, it is amenable to fairly effective regulation. Thus, the amount of pollen per cubic centimeter of medium can be reduced from much to little by taking up more of the latter in the syringe or by forcing the mixture into another container where it may be mixed in a larger quantity of the medium before being drawn into a syringe. A little practice will enable the investigator to judge at a glance whether or not the liquid contains too much pollen.

The bottom of the dish is then inverted and fitted into the inverted top with a gentle, turning movement that forces the rim of the former firmly into the vaseline, thereby effecting an air-tight seal.

The dish is then placed in an electric oven, adjusted to maintain the temperature at about 26° C.

Germination tests of pine pollen set up and conducted in accordance with the foregoing directions have yielded excellent results. Thus, *Pinus ponderosa* pollen, ranging from a few days to more than a year in age, germinated vigorously and with a negligible amount of bursting in from 24 to 48 hours. The method has also been used with similar results in testing the viability of the pollen of many other species of pine.

Qualifications of the Method

The method is economical. Numerous tests can be set up quickly in the same germination chamber; and since they can be removed and the culture dish sterilized without removing the paraffin, the same set-up can be used repeatedly. Washing under a tap will remove the test. Sterilization can be effected by briefly subjecting the paraffin and the inside rim of the dish to the heat of an alcohol flame. This operation leaves on the glass a film, which must be wiped off with a sterile instrument, but does not obliterate the holes.

The method is reliable. The technique guards the integrity of the test and the cultures may be set up in accordance with the requirements of random sampling. The use of a hypodermic syringe and closed containers enables the investigator to manipulate the pollen without exposing it to air currents, and thus the various lots of pollen are not exposed needlessly to adulteration; neither do they contribute to air currents pollen which might adulterate other lots of pollen or cultures already set up but not yet covered. Moreover, contamination by fungi does not spread from one culture to another, and thus an occasional contamination, which may be mixed in a particular supply of pollen, will not ruin the entire test. Since the size of the samples, which are selected at random, may be roughly controlled, and the cultures (plots) themselves may be arranged in the germination chamber according to a definite design, various statistical requirements may be fairly well satisfied.

The method is convenient. The work of establishing tests and examining the results is facilitated by the fact that 40 or more cultures can be set up in the same germination chamber. The use of hypodermic syringes contributes speed and precision in establishing the tests. Moreover, the cultures are very durable. This is of great importance, particularly during the pollination season, for the investigator can quickly ascertain during the test whether or not a designated lot of pollen is viable and postpone detailed studies to a more convenient time.

The cultures are easily examined and photographed under a 16 m.m. objective at a magnification of X60. For examination and photographing at higher magnifications, the desired material should be transferred to a slide.

BRIEFER ARTICLES AND NOTES

Biological Photographic Association

The ninth annual convention of the Biological Photographic Association will be held September 14-16, at the Mellon Institute for Industrial Research, Pittsburgh, Pa. The program will be of interest to scientific photographers, scientists who use photography as an aid in their work, teachers in the biological fields, technical experts, and serious amateurs. It will include discussions of motion picture and still photography, photomicrography, color and monochrome films, and processing, all in the field of scientific illustrating. Up-to-date equipment will be shown in the technical exhibit; and the Print Salon will display the work of many of the leading biological photographers here and abroad.

The Biological Photographic Association was founded nine years ago because of the growing need for expert illustrative material for scientific research and teaching. The B. P. A. was formed to act as a clearing house for new ideas, to pool experiences, record standard procedures, and disseminate information. Its aims were scientific and all services have been volunteered by officers and members on a nonprofit basis.

The B.P.A. Journal is published quarterly, constituting a volume of about 250 pages, which is furnished free to members. Membership privileges include an authoritative question and answer service; also the right to borrow loan albums and exhibits of scientific prints for study and display.

Further information about the Association and the Convention may be obtained by writing the Secretary of the Biological Photographic Association, University Office, Magee Hospital, Pittsburgh, Pa.

Timber Salvage from Douglas Fir Trees Infected with Conk Rot (*Trametes Pini*)

This study was made to determine the salvage from Douglas fir trees which showed outward signs of conk rot. These outward signs of internal rot varied from a few small scattered conks found on the lightly infected trees to numerous large, old conks and swollen trunks found on the heavily infected trees.

The timber stand examined was of the coastal Douglas fir type and consisted of old growth yellow fir (Douglas fir), western hemlock, and western red cedar. The study was made only in the fir cuttings. The site varied from fair to good and individual tree volumes ranged from 252 to 15,000 feet.

The total scale cut during the course of the study was 1,057,376 feet, of which 386,112 feet or 38 percent was infected with conk rot. Of the total scale cut, 720,892 feet or 68 percent was turned in by the scalers as net footage for logging.

When scaled the conky timber fell into the following classifications:

	Feet b.m.	Percent
Net footage for logging	106,295	27
Worthless trees	203,848	53
Extensions (method of paying fallers)	53,855	14
Plugs, culls, swamp cuts and long butts	22,114	6
Total	386,112	100

To convert this net scale to commercial log scale or water scale, it is necessary to make certain deductions in order to allow for breakage in skidding and loading, abandoned logs, and defect. By far the largest deduction is that for defect, because practically all of the logs scaled contain some stain. The defect deductions of these logs varies from as much as 60 percent to as little as 1 to 2 percent. After a survey of the present cutting operations, an estimate of 25 percent was set as the total loss in converting net scale on the ground to commercial log scale in the pond.

Assuming that the 25 percent loss is a fair estimate and using the percentages indicated by the study, the relationship of commercial log scale to worthless footage cut would be as follows:

	Feet b.m.	Percent
Commercial log scale	1,000	20
Deductions for defect and loss	350	7
Worthless trees	2,650	53
Extensions	700	14
Plugs, culls, swamp cuts, and long butts	300	6
Total	5,000	100

The ratio of commercial log scale to worthless footage cut is 1 to 4. In other words, 20 percent of the total footage of conky timber cut is recovered in the pond as commercial scale.

If all the infected trees were cut the bucking and felling costs would be as follows:[1]

	Feet b.m.	Cost per M	Actual cost
Commercial footage	1,000	$.69	$.69
Deductions	350	.69	.24
Worthless trees (fallers only)	2,650	.385	1.02
Extensions (fallers only)	700	.385	.27
Plugs, culls, swamp cuts, and long butts (buckers only)	300	.305	.09
Total			$2.31

The above figures indicate that Douglas fir trees heavily infected with *Trametes pini* should not be cut. Heavily infected trees are those on which conks appear within 20 to 30 feet from the ground and continue on up into the top of the tree. The recovery figures, however, also indicate that good footage may be expected from lightly infected trees. Consequently, in all doubtful cases the tree should be felled.

The topography and logging plans make it necessary in many cases to modify the above statement. On a setting where a skidder is to be used the timber should be clearcut. In a highlead show, where topography permits the system of not cutting heavily infected trees should be followed in order to reduce logging costs. The leaving of the heavily infected trees not only reduces the falling and bucking costs but also results in lower skidding and loading costs and transportation costs due to (1) fewer hang-ups in the rigging because of the smaller amount of cull timber and worthless footage on the ground, (2) greater production because of the smaller amount of cull timber which must be sorted over by the rigging crew, and (3) smaller amount of cull footage and low recovery logs loaded on cars. In most cases, the lower costs in skidding and loading brought about by not cutting infected trees would more than make up the increase in fixed charges on the setting.

JACK BARRETT,
Long-Bell Lumber Company.

[1]The costs used in this calculation are $0.305 per M for buckers and $0.385 per M for fallers, and are about the average contract prices paid buckers and fallers in the Douglas fir region of the Northwest.

MINERAL STAIN IN HARD MAPLES AND OTHER HARDWOODS

Both the heartwood and the sapwood of living hard maple trees, and to some extent of other hardwoods, of the Lake States and northeastern forests commonly are disfigured by deep olive or greenish black discolorations generally known as mineral stain or mineral streak. These may appear on sawed materials as individual lenticular streaks of various lengths paralleling the grain or as mass discolorations. On specimens observed the latter form has been more prevalent in or near the heartwood. During seasoning both the streaked and the mass-stained wood have a pronounced tendency to crack open along areas where the discoloration is deepest. The defect is an important factor in the utilization of species affected. It not only results in serious degrade but, because of its variable occurrence, often within comparatively limited areas, also tends to be a source of objectionable error in stumpage evaluations.

The terms mineral stain and mineral streak probably originated at the sawmill, since it is a common belief among those engaged in lumber manufacture that the discolorations are associated with accumulations of mineral matter. Such a presumption arises from the report that the stained wood dulls saws and planer knives more rapidly than bright wood. A recent preliminary study of the chemical composition and hardness of mineral-stained maple indicates that the popular conceptions in these respects have some foundation in fact.

A 30 percent solution of hydrochloric acid caused a pronounced effervescence at most stained areas to which it was applied, indicating the probable presence of carbonates in abnormal quantities. Effervescence from mass discolorations was not observed so regularly as from streaked areas but nevertheless almost always occurred at points where checking had taken place. The gas appeared to emerge mainly from vessel openings. No evolution of carbon dioxide from

bright wood of the same boards could be detected, even with the aid of a microscope.

The ash content of mineral-stained wood, as determined by incineration of splinters dissected from the discolored areas, was without exception considerably greater than that of bright wood removed from adjacent areas. The former averaged 5.2 percent as against 1.2 percent for the latter.

Forty-seven tests were made of the hardness of streaked and longitudinally adjacent bright wood, using the ball-penetration method employed at the Forest Products Laboratory. A good estimate of the relative hardness of mass discolorations could not be obtained because of difficulty in getting bright wood suitable for comparison in the same samples. The average ratio of hardness of streaked to bright wood was approximately 103/100. Although this difference is small, it is regarded as a true one. Mathematical analysis of the data discloses odds of better than 250 to 1 against the occurrence of an equal or greater difference simply as a result of accidental variations in hardness. Whether an increase in hardness of no more than 3 percent would have a noticeable effect on saw teeth and planer knives is problematical; however, it is recognized that other mechanical properties than hardness are involved in the resistance of wood to cutting.

Because of its importance, mineral stain warrants more attention than it has received heretofore. Nothing definite is known regarding its cause; consequently possibilities of limiting its occurrence are yet to be ascertained. Although a large number of stained maple specimens have been examined both culturally and microscopically for the presence of organisms, no fungus has been found consistently enough to be regarded as a possible causal agent. In fact, no fungi were found in over 50 percent of recently examined cases. There is, of course, the possibility that bacteria may be involved. This would require somewhat different technique to investigate adequately. From the evidence so far accumulated, it appears that the discolorations may be initiated by generally obscure injuries, which in some way interfere with normal physiological processes of the surrounding cells, and that although fungi occasionally may be present they are not necessarily a contributing factor. Commonly discolorations identical with those described can be definitely traced to bird pecks and similar wounds; discolorations similar in appearance regularly result from tapping operations for maple sap.[1] Stained zones are found in both the heartwood and sapwood; however, if they are formed purely as a result of physiological disturbances, their maximum development necessarily would be reached in the sapwood. The discoloration seems to spread mainly in the ray cells and vessels, which ultimately contain dark globular masses of the material directly responsible for the color. Investigations are now in progress from which it is hoped some definite conclusions may be reached as to the cause and contributing factors of mineral stain.

T. C. Scheffer,
Division of Forest Pathology, Bureau of Plant Industry.

A Pocket Biltmore Stick

A convenient and serviceable pocket-size instrument for measuring diameters and heights can be easily and cheaply made from the common concave-formed steel rule. The Biltmore "stick" may be constructed on the graduated foot rule or on a blank rule secured from the manufacturer.

If the graduated rule is used the graduations may be dimmed or removed. The clear lacquer covering and the black graduations can be dissolved with acetone or some other good solvent. On the better rules, at least, the graduations and numerals will remain in a blued finish which may be reduced or removed by a vigorous scrubbing with a swab soaked in muriatic acid. It is difficult to remove entirely the blued markings. Although these tend to detract from the clearness of the finished instrument, the faint inch graduations are useful for other measurements.

The Biltmore graduations may be applied with a lettering instrument having a tubular point,

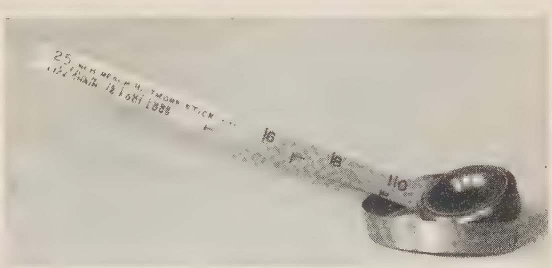

Fig. 1.—Biltmore stick made from a steel pocket rule blank.

[1] Murphey, F. T. The maple syrup crop. Penna. Agric. Exp. Sta. Cir. 186. 1937.

with a coarse pen point, or with a very fine brush. A good black enamel or Duco, thinned with turpentine, is satisfactory for marking. The finished rule is given a coat of clear lacquer for protection.

Blank rule blades may be secured from the companies making such rules. "Formed blank blued rule blades" should be requested. Blades that are not formed (concave) lack the necessary rigidity.

To mark or graduate the blued blade an asphalt base or acid-resisting ink is used. Black Duco enamel also proved satisfactory but ordinary India ink does not resist the action of the acid. When the markings are thoroughly dry the blued covering of the blade not covered by the ink may be removed by means of muriatic acid. The ink markings may be left, or removed by means of a solvent. If the ink markings are removed the resultant markings are, of course, blue. The finished rule should be given a protective coat of clear lacquer.

If the ordinary rule case is used the graduations should be placed only on the concave surface to prevent scratching by the edge of the rule case slot. By keeping the Biltmore diameter graduations on one edge the other half of the same side may be used for the Merritt hypsometer (for example, 16 foot logs at 1 and 1½ chains). To prevent confusion, two sizes of numbers can be used for the two hypsometer scales.

To facilitate the making of height measurements a lead rivet may be placed in a small hole at the lower end of rule. Care should be taken, however, not to make the rivet heavier than can be supported by the horizontally extended rule when used to measure diameters. This rivet will prevent accidentally pushing the rule entirely into the case where it cannot be grasped for removal.

A rule of heavy gauge material is much more satisfactory than those of lighter material because of the tendency for the lighter blade to bend somewhat or even to fail to support itself when extended horizontally. Additional rigidity will be obtained if the rule is shortened, say to a 50-inch maximum diameter (29-inch rule).

Most rules on the market are 6 feet in length, permitting the construction of 2 Biltmore sticks from each. A metal salve box or typewriter ribbon box may be used to carry the additional instrument. The type of rule that comes in a case permitting removal of the rule from the case is necessary if the use of the original case is desired for the Biltmore "stick."

R. Hess,
University of Maine.

The Slope Scale

In forestry field work a need exists for a low-cost and serviceable leveling instrument capable of giving rapid readings of acceptable accuracy. The slope scale here described is such an in-

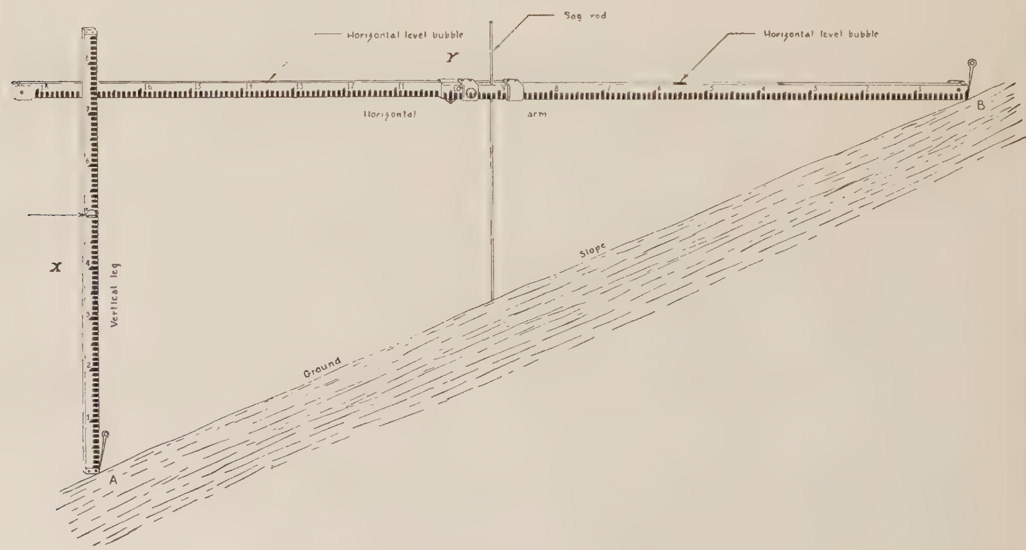

Fig. 1.—The slope scale extended full length, showing details of design and principal of operation.

strument, designed to combine the convenience of the Abney level with a higher degree of accuracy. Based in principal upon the carpenter's square or right angle, it should prove very useful in all field problems that involve the solution of small right angles in the vertical plane.

All that is necessary to make the conventional carpenter's square into a leveling instrument is (1) to elongate the sides; (2) equip the sides with leveling bubbles, and (3) make the sides mobile, one upon the other.

In elongating the square we found it best to construct the sides of oak lumber. The side intended for the vertical leg was made 8.5 feet long, and the side to be used as the horizontal arm, 18.5 feet. In order to make it easier to transport and operate in the woods, the horizontal arm was built telescopic, similar to a level rod. Both the vertical leg and horizontal arm were then graduated in feet and decimal fractions thereof.

In constructing the slope scale, we placed the vertical-level bubble at right angles to the long axis of the vertical leg at eye height. The horizontal-level bubbles were placed parallel to the lower edge of the horizontal arms at one-third and two-thirds the arm's length. Four such horizontal bubbles were installed—two on the upper edge of the horizontal arm and two on the lower edge. By thus using four bubbles, we found that the arm could be leveled easily either below or above eye height. By placing an adjustable sag rod at mid-point on the horizontal arm we eliminated all beam sag and thereby greatly facilitated horizontal leveling and increased the accuracy of leveling.

Mobility was obtained by constructing the vertical leg and horizontal arm separately and fitting them with a simple set-screw.

The successful operation of the slope scale requires the services of two men—one to handle the vertical leg and one the horizontal arm.

It is a simple operation to set up the slope scale and to take readings.

1. Place inside edge of vertical leg at lower station A (Fig. 1).

2. Place zero end of horizontal arm at upper station B.

3. If stations A and B are more than 9 feet apart in a horizontal plane, open the telescopic horizontal arm to its full length (18.5 feet).

4. Plumb vertical leg by means of its level bubble.

5. Level horizontal arm:

(a) For lengths of 9 feet or less, level the arm by using either the upper or lower pair of spirit bubbles.

(b) For lengths of 9 to 18.5 feet, level the horizontal arm by installing the sag rod and leveling bubble between zero and the sag rod, and then level the bubble between the sag rod and the 18-foot end of the arm.

6. Take the vertical reading from the vertical leg at its intersection with the lower edge of the horizontal arm, the finest scale graduation being 0.01 foot.

7. Take the horizontal reading from the horizontal arm at its intersection with the inside edge of the vertical leg.

From the readings obtained, it is apparent that the difference in elevation between point A and point B is the vertical leg reading (Fig. 1); that the projection or plane distance between A and B is the horizontal reading; that the percent of slope between A and B is the vertical reading divided by the horizontal reading $\frac{x}{y}$; and that the slope distance between A and B is the square root of the sum of the square of the vertical distance plus the square of the horizontal distance $\sqrt{x^2 + y^2}$.

Because of the instrument's simplicity of operation and the accuracy of its readings, it has a wide range of uses. In general it is useful in any type of field work involving right angles in the vertical plane, providing the projectional distance involved does not exceed 18.5 feet and the vertical distance 8.5 feet. Among the various types of forestry field work in which the slope scale has proved useful are (1) differential leveling such as (a) adjusting and checking recording instruments and reference points at stream-gaging stations, (b) establishing grade lines for low earthen dams, and foundation lines for buildings, (c) determining proper fall in sewers, culverts, roadside ditches, and spillways; (2) cut and fill work; (3) obtaining projectional or plane areas, e.g., for surface run-off plots and catchment areas on side-hill slopes and for lysimeters; and (4) determination of slope percents and slope distances.

M. H. Collett,
Southern Forest Experiment Station.

Swamp Black Gum or What?

Swamp black gum (*Nyssa biflora*), which ranges along the coast from North Carolina to Louisiana, is a close relative of black gum (*N. sylvatica*), a better known tree with an extensive range from Maine to Missouri and southward to the Gulf.

Tupelo gum and its close relative the sour tupelo gum both have a large plum-like or olive-like fruit which serves for easy identification from the first two species of gums. Tupelo gum is far more widely distributed than sour tupelo gum.

The abundance and commercial importance of swamp black gum is a mooted question among dendrologists and others interested in the distribution of tree species. According to Sargent, swamp black gum differs from black gum in being a smaller tree and in having smaller and more pointed leaves and smaller fruit with *prominently* ribbed nut-like seeds ("pits").

Is the gum of the Okeefinokee Swamp (in Georgia) to a considerable extent swamp black gum? I came to that conclusion while studying cypress, and later while discussing the subject with the late W. W. Ashe, he concurred fully in that finding. In observing gum very casually in the Louisiana delta I seemed to find considerable swamp black gum which was recently confirmed by V. H. Sonderegger. On the other hand, R. K. Winters in his recent *Forest Resources of the South Louisiana Delta* (U. S. Forest Survey Release No. 42) does not mention the swamp black gum in his list of tree species.

"Tupelo gum" (of which 4 percent is actually black gum) greatly exceeds in amount any other species of tree, Winters finds, making up about 25 percent of the total volume of both saw timber and cordwood.

Mr. Winters and the other researchers should know what they are talking about in regard to the gums of South Louisiana swamps, but according to some recent correspondence I had with him he seemed to rely for purposes of identification mainly on the ribbed appearance of the "stones" or fruit pits. How about the other characteristics of size of tree and shape of leaves?

Also how about the different species of gum and their relative abundance in the southern parts of Alabama and Mississippi and in eastern Arkansas? What are the facts? It would be most interesting to hear from foresters or others interested in the question of the gums of all or portions of the southern coastal plain.

W. R. Mattoon,
U. S. Forest Service.

Simplified Growth Determination With Increment Borer

Many of the second-growth hardwood stands in the Northeast are approximately even-aged. To ascertain the mean annual increment (m.a.i.) of such stands offers no difficulty, since it is simple to divide the total volume by the age in years. But to ascertain the current annual increment (c.a.i.)—or, more exactly, the current periodic increment—requires the use of an increment borer.

In making these measurements on a second-growth hardwood stand in the vicinity of Ithaca, N. Y., we developed a technique which may be helpful to others.

This stand is composed of many species. For each major species, borings were made at breast height, to a convenient depth, and the borings labelled with corresponding d.b.h. and notes on tree form, and vigor of crown. Thrifty, dominant trees only were bored. The range of diameters was as wide as possible.

In the office, the borings were separated by species. Then they were measured and the radial growth in inches at b.h. was recorded (by decades) on data sheets. These were then averaged and the d.b.h. of the mean sample tree was figured from basal area tables.

For example, in a 40-year-old hardwood stand on the McGowan Woods belonging to Cornell University at Ithaca, N. Y., yellow poplar showed average radial growth at breast height, as indicated in Table 1.

Table 1.—Radial Growth by Decades of Yellow Poplar 12.1 inches average d.b.h.; 1.5 inches average bark Thickness

Decade	Radial growth	Cumulative growth
	Inches	*Inches*
Last	1.31	1.31
Next	1.53	2.84
Next	1.68	4.52
Next	1.20	5.72
Next	2.07	7.79

The cumulative radial growth in diameter was next plotted on cross section paper with the decades as horizontal scale and the radial growth

as the vertical scale. Opposite decade 1 was plotted 1.31; opposite decade 2, 2.84, and so on. A harmonized curve (usually approaching a straight line) was drawn through these points and extended to the zero decade which corresponded to the present year.

From this curve the number of years required to grow the last inch in diameter at breast height was read directly and applied to the mean sample tree. For example, if 12.1 (d.b.h.) is at zero, or present year, then the vertical scale may be doubled and the number of years required for d.b.h. growth read directly from the curve at those points, as in Table 2.

Table 2.—Number of Years Required to Grow Last Inch In Diameter at Breast Height

Diameter at breast height	Number of years
Inches	
From 11 to 12	3
From 10 to 11	3
From 9 to 10	3
From 8 to 9	3
From 7 to 8	3
From 6 to 7	3
From 5 to 6	4

With these data and appropriate volume tables, the c.a.i. percent can then be figured by Pressler's or any other suitable formula. The results of applying Pressler's formula are shown in Table 3. The rapidity of growth is evidence of unusual soil fertility, helped by careful thinnings of the stand in recent years.

The c.a.i. percentages may be curved and thus harmonized, if desired.

Table 3.—Summary of Growth on McGowan Woods, Cornell University, Ithaca, N. Y.

Species	Inches diameter at breast height 6	7	8	9	10	11	12	Mean sample tree d.b.h.
	Number of years to grow last inch d.b.h.							*Inches*
White ash	5	4	4	--	--	--	--	7.82
Basswood	4	4	4	3	4	--	--	9.6
Cucumber	5	4	4	4	--	--	--	8.8
Yellow poplar	4	3	3	3	3	3	3	12.1
White pine	2	2	3	3	3	4	4	14.9
Hemlock	2	4	3	4	4	6	8	12.8
	Current annual increment percent (*Pressler*)							
Ash		8.1	7.3	--	--		--	----
Basswood		21.4	13.2	10.3	7.1	--	--	---
Cucumber		15.2	12.1	9.0	--		--	----
Yellow poplar		20.0	13.3	16.4	6.9	7.0	7.3	----
White pine		20.0	11.9	9.3	9.5	6.5	6.4	----
Hemlock		11.5	13.3	15.7	7.7	5.3	3.2	

To apply these figures, it is necessary to have a stock table, giving the volumes for each species measured, per average acre. Thus, for yellow poplar in McGowan Woods, to the volume in cu. ft. of each d.b.h. class, per average acre, was applied the c.a.i. percent above as in Table 4.

Table 4.—Stock Table For Yellow Poplar

D.b.h	Volume	C.a.i	C.a.i.
Inches	*Cu. ft.*	*Percent*	*Cu. ft.*
7	116.6	20.0	23.32
8	201.6	13.3	26.81
9	129.0	16.4	20.16
10	171.0	6.9	11.80
11	107.5	7.0	7.52
12	80.4	7.3	5.87
Totals	806.1	11.8	95.48

The mean annual increment of yellow poplar per average acre is only 20.15 cu. ft. so that the culmination of volume production will not come for several decades.

A. B. Recknagel,
Cornell University.

Soil Depth and Height Growth of Black Locust

In the past black locust has been planted on badly eroded lands in the hope that such plantings would check erosion, build up the soil, and produce a crop of fence posts; all this in a relatively few years. In many cases time has shown that none of these objectives will be reached. Most foresters now recommend that locust be planted in gully bottoms and other less exacting species on the ridges between gullies. But what of lands where much of the surface soil has been lost through sheet erosion?

Experience has proved that black locust will not make rapid growth under any and all soil conditions. Forestry workers are generally aware that there exists some relation between the growth rate of locust and the depth of the surface soil. Since the advent of the Soil Conservation Service so many thousands of black locust plantations have been established that it is now possible to gather data on early growth rate as affected by various site factors.

In this study, depth of surface soil was chosen arbitrarily as it relates to height growth of black locust. All the soils are underlain by sandy clay to clay. By surface soil the writer means the material down to this compact layer. The plan-

tations studied were in three contiguous townships in Lauderdale County, Miss. This region is in the Hatchetigbee and Holly Springs sand formations of the Wilcox group in the lower coastal plain province. The most common soil textures encountered were from very fine sandy loam to sandy loam. The most common soil series were Ruston, Kirvin, Susquehanna, and Cuthbert. All were upland soils. All plantations were on soils retired from cultivation.

The trees were planted in January, February, and March, 1935 and this study was made in August, 1938 after four growing seasons in the field. Spacing is approximately 5 by 5 feet.

It is impossible to get an accurate record of past crop history and fertilization practices.

No effort was made to evaluate the effects of slope, aspect, relative elevation, depth of water table, soil texture, and soil type. Each undoubtedly play its part.

This study emphasizes the fact, already well established in the minds of many foresters, that black locust is not a "poor land" crop. Its effective use in erosion control is limited to those places where considerable surface soil has accumulated. A farmer desiring to grow black locust for fence posts would be wise to plant

TABLE 1.—AVERAGE HEIGHT OF BLACK LOCUST TREES FOUR YEARS IN THE FIELD AT DIFFERENT DEPTHS OF SURFACE SOIL[1]

(Estimated heights from a curvilinear regression)

Depth of surface soil	Average height of trees	Depth of surface of	Average height of trees	Depth of surface soil	Average height of trees	Depth of surface soil	Average height of trees
Inches	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*
.5	1.95	10	5.41	20	8.43	30	10.83
1	2.15	11	5.73	21	8.71	31	11.01
2	2.58	12	6.03	22	8.96	32	11.23
3	2.93	13	6.36	23	9.21	33	11.38
4	3.28	14	6.65	24	9.48	34	11.53
5	3.65	15	7.00	25	9.73	35	11.68
6	4.03	16	7.25	26	9.96	36	11.85
7	4.36	17	7.58	27	10.18	37	12.03
8	4.71	18	7.83	28	10.41	38	12.16
9	5.03	19	8.13	29	10.60		

[1]Basis: 258 soil borings and 1,032 height measurements.
Standard error of estimate=2.96 feet.
Index of determination=49.2 percent.

Borings were made at ten-foot intervals between rows to determine the depth of the surface soil. The heights of the four nearest trees were measured, provided four trees fell within a radius of six feet of the boring, the mean height was recorded. The data are given in Table 1.

It is well to point out some of the important factors not considered in arriving at the values in Table 1.

In two plantations, some damage had been done by the browsing of livestock.

There is little relation between height and volume in black locust since the trees may branch many times near the ground or may have a single leader. Presumably, a correlation between soil depth and volume of woody material would be much closer than one between soil depth and height growth.

them on his best land. In sections where the locust borer is especially common, locust should be planted on deep soils as slow growing trees appear more susceptible to attack.

E. G. ROBERTS,
Mississippi State College.

MARKING AND NUMBERING TREES WITH PAINT IN STICK FORM

In marking and numbering trees for naval stores experiments, the writer obtained highly satisfactory results with a commercial product called "Markal," a paint in stick form, sold by Helmer and Staley, 2446 South Parkway, Chicago, Ill. It can be obtained in a variety of colors and can be used for marking hot objects as well

as cold. The sticks, approximately ¾-inch in diameter and 5 inches long, are packed 12 to a box, which sells for $1.05 delivered, subject to a considerable discount in quantity purchases.

"Markal" paint sticks can be used for numbering trees in the same manner as ordinary paint (Fig. 1). They have, however, the following distinct advantages over paint: (1) no brush, bucket, or other equipment is required; (2) there is no danger of spilling paint or smearing clothing; (3) neater freehand work is possible, even with unskilled labor; (4) the paint will not run; (5) numbers and marks can be applied thicker than with ordinary paint and should therefore remain legible longer; and (6) more trees can be marked per man-hour of work.

T. A. Liefeld,
Southern Forest Experiment Station.

Fig. 1.—Left, a group of second-growth longleaf pines numbered with "Markal" paint stick in March 1938 and photographed in March 1939. Right, a laborer numbering a tree with a "Markal" paint stick after the rough outer bark was smoothed with a carpenter's drawshave.

REVIEWS

Humus: Origin, Chemical Composition and Importance in Nature. By Selman A. Waksman. *2nd ed. xiv + 526 pp. Illus. Williams and Wilkins Company, Baltimore, Md. 1938. $6.50.*

The first edition of this treatise on the organic matter of soils appeared early in 1936. It was reviewed by T. E. Maki in the JOURNAL OF FORESTRY in that year (34:1007-1009).

One new chapter entitled "Humus and Soil Conservation" has been added, and the chapter entitled "Chemical Nature of Humus as a Whole" has been enlarged.

The chapter on "Humus in Forest and Heath Soils" is practically unchanged in the second edition. Apparently one unnumbered table which appeared in the first edition was accidentally omitted from p. 235 of the second.

Waksman has done much to eliminate confusion in our concepts of humus and forest-humus types, but in some instances he has added to the confused state of ideas, nomenclature, and definitions. On p. 221, in discussing the layers of the A_0 horizon of forest soils, he states "The conception of the American workers (Alway and Harmer, *Soil Science* 23:57-69. 1927) is somewhat better defined (in comparison with certain German investigators); they recognize the following distinct layers in the humus profile:

"1. Litter, comprising the upper, slightly decomposed portion of the forest floor.

"2. Duff, the intermediate layer, or the more or less decomposed organic matter, just below the litter.

"3. Leafmold or humus, comprising that portion of the profile in which decomposition of the litter is so far advanced that its original form is no longer distinguishable."

The nomenclature used above can hardly be considered the conception of the "American workers." The L-, F-, and H-layer designation used by Hesselman is more commonly employed in this country and advisedly so. The term *duff* has been used to designate broad forest-humus types by some European workers instead of a single layer of the A_0 horizon. An even more important reason for not using the term *duff* for a layer of the A_0 horizon is the fact that the term is widely used in this country to designate the entire A_0 horizon when considered by foresters as potential fuel for forest fires. Use of the term *leafmold* for the H layer or unincorporated humus is undesirable, also. It is rather widely used by gardeners and flori-culturalists to designate leaf material in various stages of decomposition.

On p. 64, Waksman states that the name *humus* should be used to designate organic matter of the soil area as a whole, whereas on pp. 6 and 7 a list of properties of humus is given which would certainly exclude the consideration of the L and F layers of forest soils as humus. However, on pp. 161 and 168, he refers to the F layer as humus.

In the opinion of the reviewer the L and F layers of forest soils bear a similar relationship to the H layer and the incorporated humus that the consolidated or unconsolidated parent material and C horizon bear to the A and B horizons of the mineral soil. In a sense the L and F layers, or at least the L layer, can be considered as the parent material of humus.

T. S. COILE,
Duke University.

Research and Statistical Methodology—Books and Reviews 1933-1938. By Oscar Krisen Buros. *100 pp. Rutgers University Press, New Brunswick, N. J. 1938. $1.25.*

For several years the writer has searched diligently for a single source of unbiased opinions of the literature in English on statistical and scientific methods. With the publication of *Methodology*, this search is ended because, to use a hackneyed phrase, this book fits the bill to a T.

The book is a cross between a pure bibliography and what might logically be called a re-

view of critical reviews of most if not all of the important books and other references in English on statistical and scientific methods, plus a generous sprinkling of closely associated subject matter. The author, with the help of the Rutgers University Library staff,[1] has made an exhaustive search through technical and scientific journals for reviews and has reproduced in this volume the pertinent statements of the original reviewers. For some references, abstracts from no less than six or eight reviews have been included. This, of course, adds much to the value of the book because the reader feels that he has not only a representative sample of the opinions of several authorities, but, for most references, a clear-cut idea of the contents of the book. Furthermore, the variety of the criticisms and comments of the reviewers adds a considerable note of interest. For references for which reviews are not available, complete citations are given.

Although the author is primarily interested in education and psychology, he has ranged through many fields: agriculture and biology, economics and business, education and psychology, engineering, forestry, geology, history, mathematics, medicine, and social sciences.

Likewise the subject matter covers a wide range. Most of the titles include either a direct reference to statistical or scientific methods or include a reference to a specific technique. In addition to the well-known statistical textbooks, titles (just to mention a few at random) such as the following are included: Statistics in Psychology and Education; Research in Administrative Law, Scope and Method; Probability and Random Errors; Linear Regression Analysis of Economic Time Series; Elements of the Mathematical Theory of Statistics. Other titles cover such subjects as the following: preparation of theses and technical articles, style manuals, graphic methods, alinement charts, methods for locating educational information and data; practical applications of punched-card sorting and tabulating machines; libraries for scientific research in Europe and America; diction of psychology; a history of historical writing; reports of research conferences, and many others.

The book is arranged for ready reference. In the front of the book is a classified index to books arranged under two major headings: research methodology and statistical methods, with subheads of fields, techniques, and other subdivisions. Under the subhead of textbooks, for example, the books are listed as: very elementary, elementary, etc. Separate indexes for titles and authors are included.

Has the writer found this book of any practical value? Yes indeed. He has already ordered two of the books and several of the bulletins he did not know were in existence until *Methodology* reached his desk.

Probably not every research worker should have a copy of this book, but certainly there should be a copy in every library in every organization conducting research the results of which are obtained as quantitative data. Without question, all agricultural, range, forest, and other experiment stations, forest schools and other institutions of higher learning, and branches of research in industry should have this book.

The author expects to publish this work annually—provided it proves of real value. Let's show him that his efforts in making this invaluable contribution available are really appreciated.

R. M. Brown,
University of Minnesota.

The Growth and Nutrition of White Pine (*Pinus strobus*, L.) Seedlings in Cultures with Varying Nitrogen, Phosphorous, Potassium and Calcium. By H. L. Mitchell. *Black Rock Forest Bull. 9, vi + 135 pp. Illus. Cornwall-on-the-Hudson, New York. 1939. $1.50.*

Of outstanding importance in American tree nurseries is the ever-present problem of maintaining proper soil fertility. As soils of no two nurseries are alike, each nurseryman has been obliged to rely mainly upon his own skill, resourcefulness, and test plots in meeting this problem. Soil specialists have prescribed general methods by which nursery soils may be built up and maintained, but the nurseryman is still uncertain as to the fundamental nutrient requirements of tree seedlings, and unable to determine how well these requirements are being supplied in his own nursery. The nutrition work begun by Gast at the Harvard Forest and continued by Mitchell at the Black Rock Forest affords a new method of ap-

[1]Facilitated by a grant from the Works Progress Administration.

proach to this problem which promises to lead eventually to a more intelligent and effective use of fertilizers. This latest paper by Mitchell will prove the most useful because it draws upon the earlier work to give a well-rounded treatment of the subject.

Northern white pine seedlings were grown for 108 days in sterile sand to which nutrient solutions were applied. All nutrient elements, save one, were supplied at approximately optimum concentration; this one was varied over a wide range to determine the minimum, working, optimum, and toxic concentrations. The optima for the four elements studied were: 300 parts per million of nitrogen, 350 p.p.m. of phosphorus, 150 p.p.m. of potassium, and 200 p.p.m. of calcium. Concentrations above these levels proved to be toxic; those below, to be inadequate for most rapid growth. Mitchell points out that though these concentrations are optimum in sand nutrient cultures, they are likely to be below optimum in nursery soils where a large proportion of the nutrients may be absorbed in organic or inorganic base-exchange compounds from which they are liberated slowly. Furthermore, there appear to be important differences among species in nutrient-absorbing power. Soil analyses are likely to prove misleading in these cases. To arrive at the nutrient needs the plants themselves should be analyzed.

Mitchell found that throughout the minimum, working, and optimum ranges the nutrient concentration within the shoots of the seedling was highly correlated with the concentration of these elements in the nutrient solutions of sand cultures. Corresponding to the optimum external concentrations given above, the optimum internal concentrations for white pine, based on dry weight, were found to be: nitrogen, 2.50-3.26 percent; phosphorus, 0.56-0.67 percent; potassium, 1.50-1.72 percent; and calcium, 0.28-0.33 percent. These values are nearly identical with the concentration of these elements in hardwood leaves when nutrient conditions are optimum for growth. Mitchell states that owing to absence of flowering and fruiting the use of foliar analysis to diagnose nutrient requirements of tree seedlings is fraught with fewer difficulties than similar use with agricultural plants. It was also discovered that nutrient concentrations toxic to two-weeks-old white pine seedlings were optimum for growth of older seedlings, indicating an increase in requirements with age.

By using internal concentration as a guide, Mitchell was able to grow in the Black Rock Forest nursery 2-year-old seedlings of white pine larger in size and with better balance between root and shoot than ordinary 3-0 or 2-1 nursery stock. Presumably this technique may be applied with equally satisfactory results in other nurseries.

The refined technique introduced by Gast and Mitchell sets a new standard for research in tree nutrition. For instance, where small numbers of plants must be used, correction for seed weight is essential. Mitchell shows that dry weight of seedlings throughout the first year is directly correlated with dry weight of food reserves in the seed. This in turn is correlated with fresh weight of seed provided the seed is of the same crop and from the same parent tree. By correcting for seed size and for total solar radiation, and by using the same seed source, sand cultures of different years were reduced to a comparable basis. Mitscherlich equations, with slight modifications, were fitted to all data on yield. These were found to hold throughout the important ranges of concentration. Effective use of statistical treatment is made throughout the paper.

The bulletin is well organized, and the essential findings are graphically presented, enabling the impatient reader to absorb the substance with only occasional reference to the text. The section dealing with nursery practice contains speculations requiring further proof, but these serve to point out what may be anticipated from continued well-directed research in tree nutrition.

HARDY L. SHIRLEY,
Lake States Forest Experiment Station.

Der Ausschlagwald—Besonders in Europa —und seine Umformung in Hochwald. (The Coppice Forest—Particularly in Europe—and its Conversion to High Forest.) By Johannes K. Papaiannou. *279 pp. Illus. Selbstverlag, Thessalonike, Greece. 1938.*

With unusual thoroughness, Dr. Papaioannou discusses an interesting forestry problem. The economic superiority of the high over the coppice forest is well-known. Today we look upon the high forest not only as *the* timber producing forest, but also as the system of management which

most completely utilizes and preserves soil fertility in connection with the greatest volume production. Because of this, foresters in many lands have started to change their coppice forests into high forests. However, the oldest and most extensive conversions have been confined to Germany, France, and Switzerland. It is with the conversions in these countries that the author concerns himself.

The text of this monograph is divided into three parts: (1) A historical resume of conversions; (2) choice of species and silvicultural systems; and (3) the conversion process itself.

A conversion involves silvicultural and management considerations—both of equal importance. Silviculturally speaking, the author defines a conversion as "a change in the type of reproduction of a forest in such a way that sprout reproduction is replaced by reproduction through seed; while in terms of forest management it means the discontinuance of fuelwood production and the beginning of timber production."

Papaiannou points out that much of the success of a conversion depends on the choice of species which go into the making of the new forest. Species should first of all be chosen for their economic value and their soil-improving and preserving power. They should be fast growing, especially when young, so that they can quickly get away from sprout competition, and eliminate the necessity for cleanings and liberation cuttings. The new species should also be windfirm. To make up for the lessened yields during the conversion process, they should produce early and plentiful intermediate yields. They should mature, or at least produce merchantable timber, comparatively soon. A certain degree of tolerance is also highly desirable.

The author discusses these characteristics for adaptation to conversion as they pertain to some forty of the more important species that could be considered. European beech (*Fagus silvatica*) leads the list of the twenty-odd deciduous species, and Norway spruce (*Picea abies*) is stressed most among the conifers. The list includes more than 15 American species, of which *Quercus borealis, Fraxinus americana, Pseudotsuga douglasii viridis,* and *Abies grandis* receive particular emphasis. As mixed forests are more nearly like climax forests than the pure conifer forests established early in European forest history, the author emphasizes two principles, viz.: the preservation of deciduous forests with an abundant introduction of conifer species, and the establishment of mixed forests.

It is pointed out that the many alleged advantages of the selection forest over the even-aged forest have not yet been clearly proved, but even if they had been, they could not be of such outstanding superiority as to warrant a planned discontinuance of the even-aged forests and the many advantages connected with them. Of course, where a selection forest is obviously the best form, (as it often is in the case of public forests, or for the small forest owner, or for forests near cities where,aesthetic values are of prime importance) conversion efforts should be directed toward that form. Selection forests as a rule are composed only of tolerant species. Selection forests with intolerant species are possible but only at the price of inadequate stocking and an inferior quality of wood.

Depending on whether sprouting and/or seeding ability is present in the coppice forest, and whether the to-be-developed high forest should have an even- or uneven-aged form, and finally on the kind of reproduction desired, the following conversion methods are recognized and expounded.

I. Conversions *with* risk of sprouting.

1. By means of clear-cutting, shelterwood cutting, alternate strip cutting, or combinations of the three, and preparatory or cultural measures for restocking the area.

II. Conversions *without* risk of sprouting.

1. By means of grubbing and artificial establishment of the high forest.

2. By means of rotations which will cause the loss of sprouting ability and aim for seedling regeneration. Restocking by natural or artificial means.

III. Mixed methods.

1. Conversions leading to an uneven-aged forest.

a. By means of compound coppice cuttings.

b. By means of a single cutting followed by planting.

c. By means of a selection-like favoring of seedlings, particularly conifers.

2. Conversions leading to an even-aged forest.

a. By means of reproduction cuttings in the

underwood, in order to establish seedling regeneration.

b. By means of conversion cuttings, through which, in a compound coppice stand, the most desirable age-class is favored.

c. By means of gap cuttings (Löcherhiebe)—very similar to conversions through selection cuttings or group cuttings.

Because of the great diversity of conditions ordinarily found within coppice forests, a single conversion method is seldom adequate. As a matter of fact, differences in coppice stands can usually be turned to good advantage by choosing the proper conversion methods. This is just one of a number of instances in conversions where not only is a thorough knowledge of silvicultural and management principles indispensable, but a considerable amount of practical experience and a certain keen sensibility to things pertaining to the forest—a "flair forestier" or "Phantasie"—are also essential.

In concluding, the author emphasizes that, although he has gone into considerable detail, he has attempted only to discuss the principles of conversion along with the possible advantages and disadvantages. No hard and fast rules can be laid down. However, these principles can broadly and cautiously be applied in other countries, even those with different forest and climatic conditions. The success of any silvicultural measure is, after all, dependent on its skillful adaptation to the existing local conditions.

To American foresters interested in conversions, this discussion should prove helpful.

John F. Godfrey,
Soil Conservation Service.

CORRESPONDENCE

May 18, 1939.

Managing Editor,
Journal of Forestry.

DEAR SIR:

I read with great interest the stimulating article, "Controlled Burning in the Western White Pine Type," by Kenneth P. Davis and Karl A. Klehm, in the May issue of the JOURNAL. They admit it is a controversial matter and so I'll try to prove that I agree with this viewpoint of theirs, even though I don't entirely agree with some of their other conclusions.

I have no question to raise about the desirability of controlled burning in areas recently burned where much dead slash and down timber clutter the ground. Here the fire hazard is likely to be so extreme, as they point out, that without reburning the area by design it will probably be reburned by accident with far more damaging results than would occur with controlled burning. Furthermore, on such areas no existing green forest is destroyed.

In mature stands from which only the white pine and cedar has been removed, I cannot believe that light burning is justified. Judging by the picture on page 403, such stands retain all the characteristics of a forest. Aesthetically, they appear quite attractive. No doubt there is considerable slash underneath the canopy, but this will rot down in a relatively few years. Certainly picture D, after the completion of the controlled burning, is not even remotely comparable in attractiveness to picture A with its mature stand of hemlock, fir, Douglas fir, larch, and the unmerchantable white pine and cedar. Nor can I imagine, even twenty years from now, when the trees planted on "D" may have grown to a height of thirty feet, that such a stand will be as beautiful as the old growth stand casting a deep shade over the ground in "A." Aesthetically, the cull stand left after cutting the cream of the timber is greatly preferable to what results from the controlled burning sequence.

Davis and Klehm of course admit that the objective is not an aesthetic one but to make use of available growing space by reproducing commercially valuable stands. Admittedly, the cull hemlock and firs will probably never be commercially valuable. However, viewed only from the standpoint of producing merchantable wood a number of questions arise.

The assumption through the Davis-Klehm article would seem to be that the cull stand left after logging will always be a cull stand. Actually, from what I recollect about the forests of northern Idaho, I shouldn't think this would be true. Overmature stands generally do have plentiful reproduction coming up wherever a gap is made in the crown canopy. There is often considerable advance growth right under the old trees. I should think that with the openings made by the removal of white pine and cedar plus the slow crumbling away of the rotten hemlock and fir, that young trees would develop and the stand would not be entirely a cull forest even though not a hundred percent commercial one. While I will agree that from a purely commodity standpoint a young stand established after destroying the remains of the old one would have a higher percentage of merchantable timber a hundred years from now, if it escapes fire, than would the cull stand if it were allowed to develop from now on naturally, nevertheless the difference is merely one of degree and not a complete contrast.

Of course, it may actually be that a hundred years from now the cull stand will be ready for cutting again and the replanted stand will be denuded. I should think the cull stand with its shaded forest floor would remain much moister and easier to protect from fire than the one which was clear cut and burned. What is the relative probability of fire in plantations and cull stands after white pine logging? I haven't any statistics on this subject and perhaps my surmise is wrong, but in any event I should think this factor would have an important bearing on the problem.

According to the figures of Davis and Klehm, the cost of burning and replanting a cull stand amounts to approximately $40 an acre. The

money for doing this is borrowed by the government at approximately 3 percent interest. Figuring 3 percent at simple interest, this would quadruple the investment in a hundred years, and amount to $160. Will the replanted forest be $160 per acre more valuable from a purely commodity standpoint in a hundred years than the culled forest which was allowed to develop naturally? Also, wouldn't you have to figure an increased protection cost on top of this? Even without figuring any interest or the increased protection cost, will the new stand be worth $40 more per acre at the end of the hundred years for commodity purposes?

As I understand it, the public forest lands already denuded exceed our capacity to restore them for many years. Would it not be better to devote our available planting funds to lands which without planting will be entirely denuded than to wreck the forest on lands which now contain at least an attractive cover for the ground?

Finally, are we sure this nearly total exposure of the site by burning won't cause very serious damage to the area ecologically as compared with what happens to those stands where a good canopy and ground cover is left after logging? Of course, I recognize what the authors state—that the white pine type is naturally a fire type. However, many white pine stands which came up in burns didn't result from the complete destruction of the old stand. Considerable stands of timber, many individual thick barked trees, and much ground cover and humus were not destroyed. In those stands where the fire wiped out practically all the old timber, ground cover and humus, are we sure that the site has not seriously deteriorated? Also, if it is granted that one burn in a millenium may not seriously injure the site, does it necessarily follow that white pine stands can be burned over more often without real damage to their growing capacity and serious erosion?

This brings us to one more argument against controlled burning. Isn't the cull forest left after highgrading the white pine and cedar far preferable to the forest subjected to controlled burning from the standpoint of preventing erosion and stabilizing streamflow?

I think Davis and Klehm have written a swell article, just because it does set a person to thinking. Perhaps their viewpoint is correct. Perhaps they have answers to some of the questions I raised which will indicate that my doubts are unfounded. Nevertheless, before I go picketing cull stands of hemlock and white fir and Douglas fir and larch in northern Idaho, with a placard saying "This area unfair to silviculture," I'd like to have most of my questions answered.

BOB MARSHALL.

DEAR DR. SCHMITZ:

During a recent field trip I had occasion to talk with a certain individual connected with a large mid-western university. Among other things, I discussed with him a review he had written for the JOURNAL OF FORESTRY and asked if I might have a reprint. He informed me that he had none, although he had received several similar requests since publication of the review.

He said that, although not a forester, he had been asked to review a certain publication dealing with forestry for the JOURNAL. He had complied with this request and soon received a letter accepting the review and enclosing a price list for reprints. Since he felt no obligation to obtain reprints for distribution, for the most part to foresters, he did not do so. The apparent reaction on his part was that the Society should have supplied him with a small number of reprints free of charge as a mark of appreciation for his efforts.

This incident makes me wonder if, as a matter of policy, we should not consider the advisability of supplying individuals, who are formally requested by the editorial staff to make reviews for publication in the JOURNAL OF FORESTRY, and who are not members of the forestry profession with a minimum number of reprints as a token of appreciation and to alleviate incidents such as I have described. I do not know, of course, what additional cost to the Society this procedure would entail. This phase of the matter might require some investigation.

In my opinion only members of professions other than forestry should receive free reprints, and then only if they were specifically requested to submit a review by the editorial staff. If this were not considered expedient, at least it would seem desirable to eliminate the routine procedure of sending a price list to the reviewer and, as an alternative, one or two copies of the JOURNAL containing his review might be sent him.

ALF Z. NELSON,
U. S. Forest Service.

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